

Platinum Series

Process Oxygen Analyzer

Instruction Manual

P/N 99000001



DELTA F CORPORATION

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Instruction Manual

P/N 99000001
Revision G

Covers Firmware
Version 2.82 And Higher

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SPECIAL WARNINGS

DANGER



Line voltage exists in the Oxygen Analyzer Enclosure. If the enclosure door is open, **DO NOT REACH INTO THE ENCLOSURE** when the Analyzer is connected to AC power.

CAUTION



Do not operate the Platinum Series Process Oxygen Analyzer at oxygen concentrations that are over-range for extended periods of time. Trace and low percent range sensors may be damaged if exposed to high levels of oxygen, e.g., air, for periods of time >15 minutes while on power.

If an exposure is unavoidable, turn off power to the instrument, or deactivate the sensor polarization voltage (See Section 6.3.4).

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1.0 Overview Of This Manual

This manual is organized in sections that will provide progressively more detailed information. This section provides information about this manual, introduces the Delta F Platinum Series Process Oxygen Analyzer, and defines some terms that will occur throughout the manual.

The Analyzer is a sophisticated instrument with many features that need to be discussed in detail. However, Section 2 of this manual will describe a procedure to get the Analyzer up-and-running quickly without going through all of the detail. Later sections will delve into the details of the Analyzer's features to help customize its operation.

Section 2 assumes that the user has an instrument that does not include options. If the instrument has any of the options listed below, some minor changes to the Quick Set-Up Procedure in Section 2.0 will be necessary. The changes that are necessary can be found in Section 3, under the selected option.

Option	Section	Change To Quick Start-up Procedure
Filter	3.5	Plumbing Filter for Particulates or Mists
Filter and Regulator	3.7	Plumbing Filter for Particulates or Mists
Stainless Steel Outlet	3.10	Removal of Sensor Assembly
Welded Gas Delivery	3.11	Removal of Sensor Assembly
Panel/Rack Mount	3.19	Enclosure Mounting

Section 3 discusses optional equipment and features. Useful information about specific options for the Analyzer can be found in this section.

Section 4 describes how the Analyzer is connected to external devices through the connectors at the back of the Analyzer. Details about communication ports, relay ports and other optional ports can be found in this section of the manual.

Section 5 covers gas sample preparation and delivery. This section discusses sample flow, pressure, and gas quality, for both normal sampling and calibration.

Section 6 describes how to do normal operation and program the Analyzer for specific requirements. The user will be taken step-by-step through the screen menus to customize the Analyzer's set-up.

The remainder of the manual covers Theory of Operation (Section 7.0), Service (Section 8.0), Safety (Section 9.0), Specifications (Section 10.0) and Warranty (Section 11.0). Appendix A lists replacement parts and part numbers.

1.1 Introduction

Many factory options are available for the Analyzer. For simplicity, it is assumed that the user has a basic Analyzer without options. Therefore, this section will not cover operation of Analyzers equipped with the high-resolution feature, pump, flow switch, heater, regulator, filter, alarms, etc.

Every Analyzer can measure and display oxygen, and can output the signal to an external device. The analog output range can be scaled for specific needs. Standard outputs are non-isolated 4-20 mA and 0-10 VDC.

Figure 1-1 shows the basic Analyzer. Figure 1-2 shows some of the major internal components.

Before setting-up the Analyzer, some definitions and warnings need to be stated.

1.2 Definitions And Warnings

1.2.1 Explanation Of Graphic Symbols



This symbol alerts the user to the presence of “dangerous voltage” within the Analyzer’s enclosure or to the possibility of physical danger to personnel or permanent damage to the equipment.



This symbol alerts the user to the presence of important operations and/or maintenance instructions in this manual.

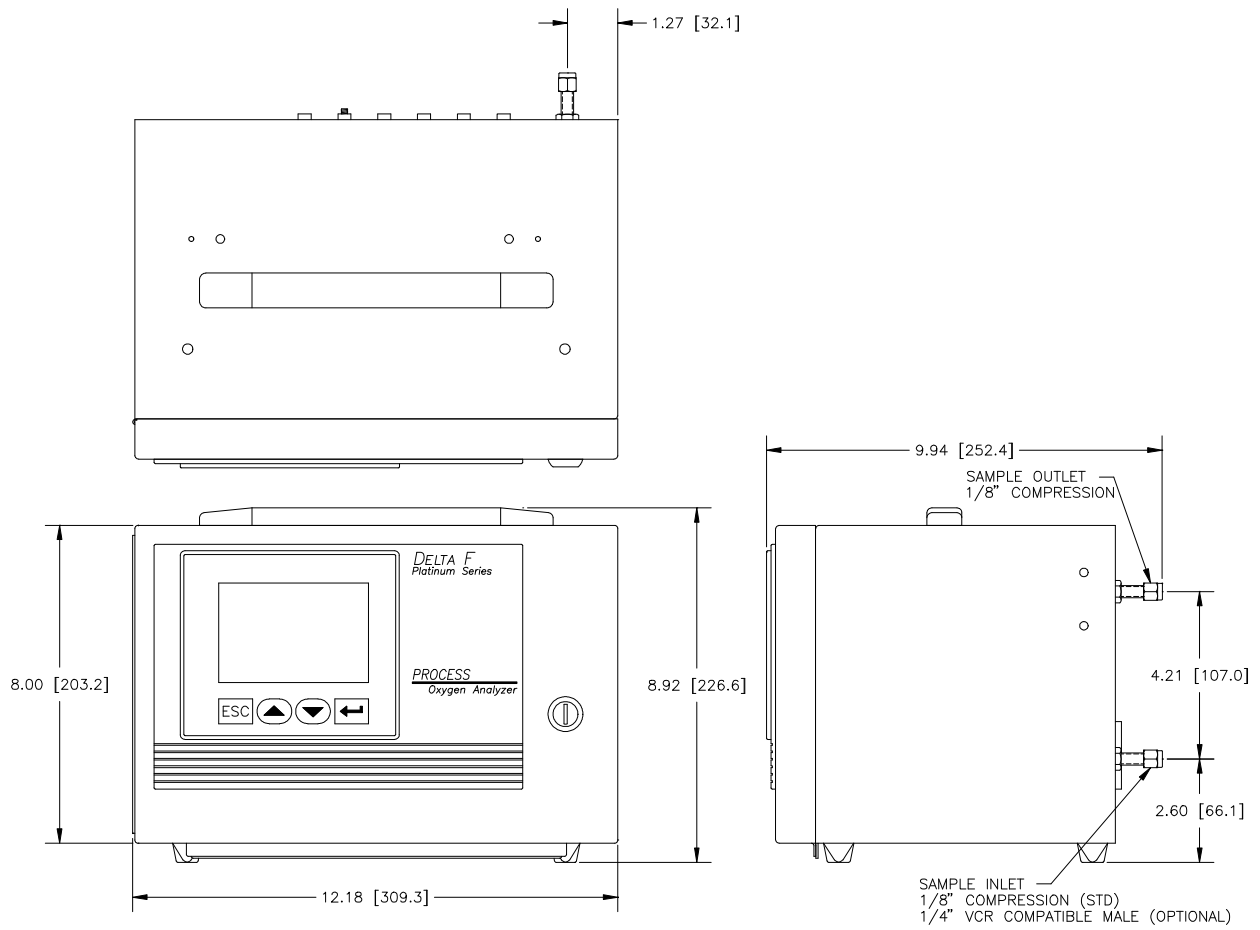


FIGURE 1-1 DELTA F PLATINUM SERIES PROCESS OXYGEN ANALYZER

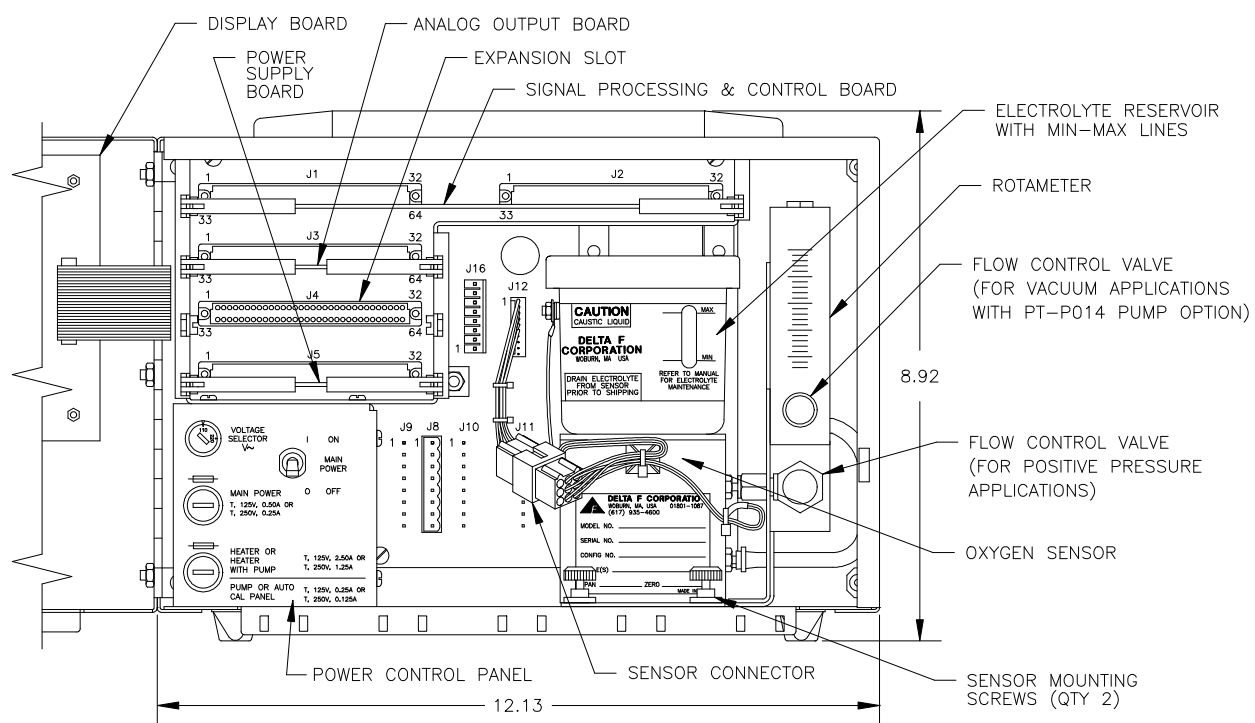


FIGURE 1-2 MAJOR INTERNAL COMPONENTS

1.2.2 Definitions

DANGER: Indicates that the information is provided to alert the user to a potential personal hazard or the potential of damage to the product.

CAUTION: Indicates that the information is provided to alert the user to the potential of damage to the instrument, or an incorrect result if the directions are not followed.

NOTE: Indicates that the information is provided to increase the efficiency, accuracy or reliability of the Analyzer.

DANGER



Potentially hazardous AC voltages are present within this instrument. Leave all servicing to qualified personnel. Disconnect all AC power at the source when installing or removing AC power connections, or data signal connections, as well as when installing or removing the sensor or the electronics or charging or draining electrolyte. Do not connect this Analyzer to a power source until all electrical connections within the instrument are complete.

CAUTION



Do not set-up or operate the Oxygen Analyzer without a complete understanding of the instructions in this manual. Chapter 9.0, Safety, contains safety instructions and the electrolyte Material Safety Data Sheet (MSDS). To protect yourself and the instrument, please read Chapter 9.

RF DISCLAIMER

This instrument generates, uses, and can radiate small amounts of radio frequency energy. There is no guarantee that interference to radio or television signals will not occur in a particular installation. If interference is experienced, turn-off the instrument to determine if the interference disappears. If it does, try one or more of the following methods to correct the problem:

1. Reorient or relocate the receiving antenna.
2. Move the instrument further away from the receiver.
3. Plug the instrument or receiver into a different AC outlet so the instrument and receiver are on different circuits.

CAUTION



Do not use hand-held radios with greater than 0.5 Watt power within fifteen feet of this instrument. Otherwise, significant spikes in O₂ readings may occur when the radio is transmitting.

1.3 Unpacking

When unpacking the instrument, notice the condition of the package and its contents. If any damage is apparent, immediately notify the carrier and the Delta F Customer Support Services Department at 781-935-5808. Do not proceed with the installation.

Check the contents against the packing slip to make sure that the shipment is complete. Unattached equipment may be included with the Analyzer in supplemental packaging.

All Analyzers are shipped with the following parts:

Two Bottles of EO5 Electrolyte	P/N DF-E05
Power Cord w/Connector (115 VAC only)	P/N 59017300
Wash Bottle	P/N 67002401
This Manual	P/N 99000001

Note: Any damage claims and shortage reports must be reported to Delta F Corporation within 10 days after receipt of the shipment.

Keep the packing carton for future use. The carton is designed to protect the Analyzer and should be used if shipping becomes necessary.

Open the Analyzer door and inspect the inside of the unit to be sure that no components have become loosened or dislodged. Remove any shipping materials.

CAUTION



Check the printed circuit boards (PCBs) to be sure they are seated properly.

1.4 Verify Operating Voltage

The Platinum Series Process Oxygen Analyzer is configured at the factory to operate on 100-120 VAC or 220-250 VAC as specified on the purchase order. The factory setting can be verified by noting the red mark in the box imprinted on the back panel of the Analyzer near the power receptacle, and by looking at the voltage selector switch on the internal power panel, Figure 1-2. Analyzers that are ordered to operate on 220-250 VAC are not supplied with a power cord, due to the variety of plug styles used throughout North America and the world. The Analyzer has an IEC 60320 C13 inlet on the rear panel that will accept a customer supplied power cord having the appropriate local 220-250 VAC plug on one end and the standard IEC 60320 C13 connector on the other end.

CAUTION



On units with a pump and/or heater, the Voltage Selector switch must not be moved from the factory-set position or the pump and/or heater may be damaged. The pump and heater are voltage specific. If it is necessary to operate these Analyzers on a voltage, different from the factory-set voltage, contact the Delta F Customer Support Services Department at 781-935-5808.

To change the operating voltage on units without a heater and/or pump, simply move the voltage selector switch to the appropriate position and replace the main fuse. For 115 V operation a 0.5 Amp fuse (P/N 45002361) is required, while for 230 V operation, a 0.25 Amp fuse (P/N 45002301) is required. The basic Analyzer uses less than 25 watts of power, and is compatible with both 50 and 60 Hz.

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2.0 Quick Set-up Procedure

This procedure will assume that the Analyzer has a range of 0-100 ppm, is not equipped with options (Basic Analyzer Configuration), and has the analog voltage output set to 0-10 VDC. Options may affect the set-up procedure described in this Section. If the Analyzer is equipped with options, refer to Section 1.0 and Section 3.0 to determine changes to the set-up.

Note: The representative screens shown throughout this manual have values that will not necessarily match with the actual values displayed during set-up.

2.1 Tools Required

The following tools are required to install the Basic Analyzer Configuration.

- 1/2" Open End Wrench (For bulkhead fitting retaining nut)
- 7/16" Open End Wrench (For compression nut)
- 1/8" Flat Blade Screwdriver

2.2 Adding The Electrolyte

DANGER



The electrolyte is a caustic solution. Review the Material Safety Data Sheet (MSDS) in Section 9.2 before handling the electrolyte solution.

The sensor is shipped dry and must be charged with electrolyte before it is operated:

- a. Remove the 1/2" inlet bulkhead retaining nut from the inlet bulkhead fitting at the back of the Analyzer, reference Figure 3-2. Do not remove the four small Allen head screws that hold the bulkhead plate to the back panel.
- b. Inside the enclosure, disconnect the nine-pin sensor connector located near the front of the sensor, see Figure 1-2.
- c. Unscrew both sensor mounting thumb-screws at the base of the sensor.

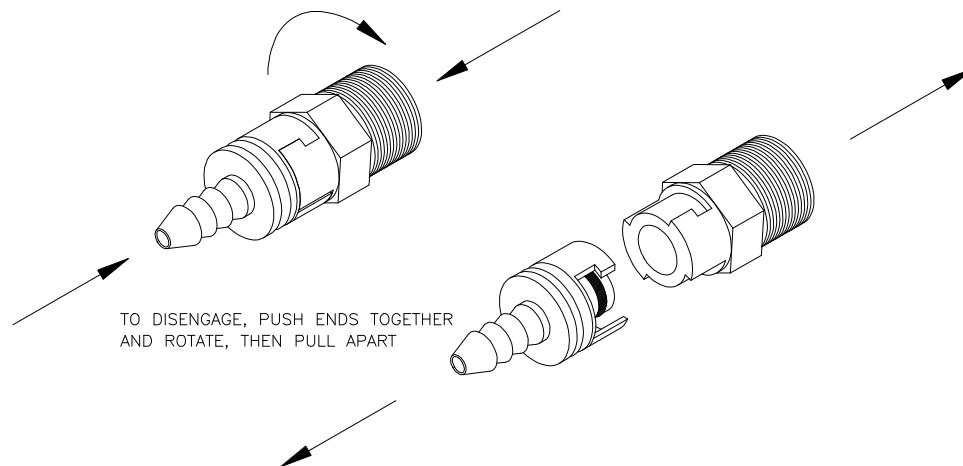


FIGURE 2-1 QUICK DISCONNECT FITTING AT ROTAMETER OUTLET

- d. Pull the Sensor Assembly forward a few inches.
- e. Disconnect the "quick-disconnect" fitting at the top of the rotameter by pushing both halves of the fitting together and rotating one to the release position. See Figure 2-1 for details.
- f. Remove the Sensor Assembly from the instrument.
- g. Unscrew the black cap from the electrolyte reservoir.

Note 1: If the sensor is being charged with electrolyte for the first time, the reservoir should be filled with deionized or distilled water up to the maximum level line on the reservoir label.

Allow the sensor to sit for 15 minutes. Check for leaks at the base of the reservoir and at the seams and corners. If a leak is found, report it to the factory before proceeding. Drain the sensor.

Note 2: If the electrolyte is being changed, remove the reservoir cover and drain the electrolyte into a suitable (polyethylene, etc.) container for proper disposal. Thoroughly flush the sensor with distilled or deionized water 2 to 3 times before recharging.

- h. Add the entire contents of one bottle of electrolyte (DF-EO5) to the sensor.

- i. Top off the sensor up to the MAX line with distilled or deionized water to maximize the time until the next water addition will be required. Replace the screw cap and hand tighten securely.
- j. Install the sensor by repeating steps a. to f. in the reverse order.

Note: The inlet bulkhead fitting is oriented to seat into a retainer at the inside back of the enclosure. When reinstalling the Sensor Assembly, be sure the bulkhead fitting is positioned with the flat sides of the hex horizontally oriented before replacing the nut. The nut should be tightened by hand until it contacts the nut plate and then gently tightened with a wrench. Only a ten degree rotation of the wrench is required to tighten the nut once it contacts the nut plate. If the nut is over tightened the threads may be damaged, permanently freezing the nut on the fitting.

2.3 Sample Gas Connections

The sample gas inlet and outlet lines at the back of the instrument have stainless steel 1/8" compression bulkhead fittings. Before connecting gas lines to the Analyzer, install a gas nut and compression ferrule on the tubing. Connect the inlet and outlet lines to the bulkhead fittings at the back of the Analyzer. A backup wrench is not needed since the bulkhead fittings are secured by retainers that are inside the instrument. Do not over-tighten fittings.

Sample gas pressure and flow requirements are briefly discussed in Section 2.6, Powering Up. For full information on sample gas preparation and delivery see Section 5.0.

2.4 Electrical Connections

Make sure the power switch in the Analyzer is in the OFF position. See Figure 1-2. Plug the supplied line cord into the receptacle at the back of the Analyzer before connecting the line cord to power.

2.5 Standard Outputs

An output signal can be connected to other instruments by using the non-isolated 4-20 mA output and the 0-10 VDC output at the back of the Analyzer. Delta F has provided mating connectors for the instrument.

The standard outputs use the Options Port, J10, shown in Figure 2-2. Pin 1 is at the top for all output connectors.

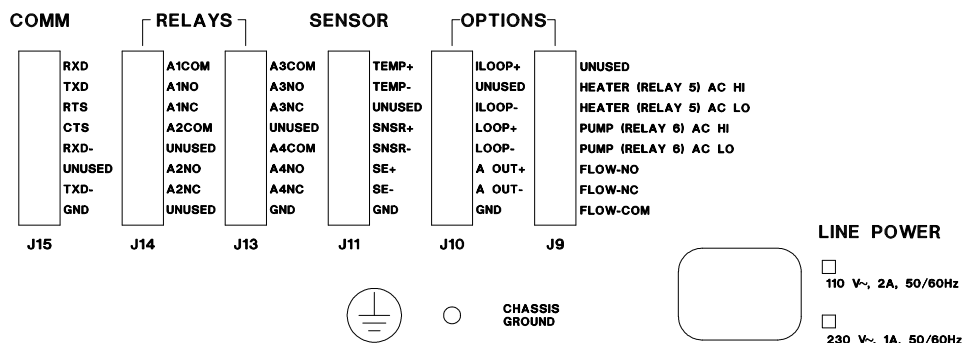


FIGURE 2-2 PINOUTS AT ENCLOSURE REAR

The 4-20 mA output is isolated from earth (chassis) ground. This output is not electrically isolated from the voltage output. An internal 28 VDC loop supply is provided. The maximum loop resistance is 1K Ohms. The 0-10 VDC output has a minimum load resistance of 1K Ohms. Both outputs are protected by 100 mA fast acting fuses (user replaceable) and internal voltage clamping circuitry.

The 4-20 mA output is connected to pins J10-4 (LOOP+) and J10-5 (LOOP-); the 0-10 VDC output is connected to pins J10-6 (A OUT+) and J10-7 (A OUT-).

2.6 Powering Up

The Analyzer is designed to operate at 0.2 to 1.0 psig inlet gas pressure. If the line pressure exceeds 10.0 psig, do not use the flow control valve that is provided with the instrument to regulate pressure. If the sample supply gas pressure exceeds 10.0 psig, or will be fluctuating, install a pressure regulator in the inlet gas line to regulate the pressure to 5.0 psig or less. The flow control valve is used to set the flow at 2.0 standard cubic feet per hour (scfh).

CAUTION



Over-pressurizing the Analyzer can result in permanent damage to the sensor and optional pump.

Note: Check that the gas sample being delivered to the instrument is expected to have an O₂ concentration that is below the full scale range limit of the Analyzer. Allow the gas to flow through the Analyzer for approximately 30 to 60 seconds before powering-up.

Turn on the power to the Analyzer using the main power switch on the internal power panel. The unit will undergo a series of diagnostic procedures for approximately 5 seconds. Then the display will present the Delta F logo.

After 15 seconds, the display will show Figure 2-3 (values shown are only representative). The Analyzer may display an OVER RANGE condition for the first couple of minutes of operation. This is normal even if the actual O₂ concentration is well within the measuring range of the Analyzer. However, if the reading is not on scale within 15 minutes, proceed to Section 8.2, Troubleshooting.

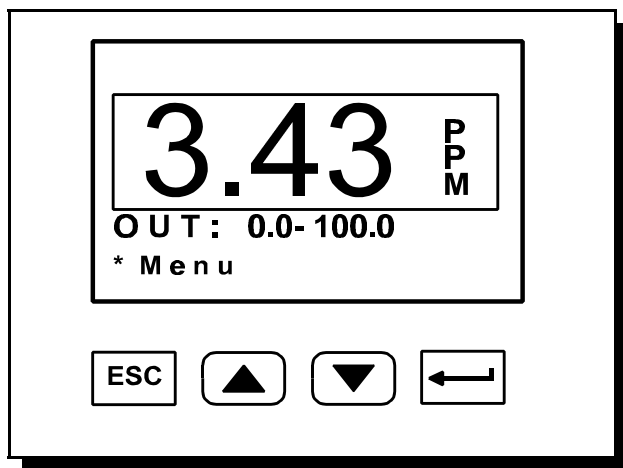


Figure 2-3

The 3/4" high digits show the concentration of oxygen in parts per million (ppm) or percent (%) in the sample gas stream.

This completes the set-up of the basic model Analyzer. The next sections will discuss Options, Output Connections, Sample Gas Preparation and the User Interface.

2.7 Operational Recommendations

The following information appears in other places in this manual. However, it would be helpful to review this list prior to operation.

- 1) Always establish sample flow before powering up the Analyzer.
- 2) Never operate a trace level or low percent Analyzer for more than a few minutes while exposed to air.
- 3) Verify proper electrolyte level at least once every 3 months in trace level Analyzers. See Section 8.1.3 for details. On very dry gas streams check monthly, initially, and adjust the check frequency to coincide with how fast water is being evaporated in your application. Always top off with distilled or de-ionized water. Never top off with electrolyte.
- 4) For clean gas applications (defined in Section 8.1), check span calibration every 12 months. For applications with background gases containing aldehydes, alcohols, or acids, span calibration should be checked every three months. Depending on the specific molecular species and quantity of aldehydes, alcohols, or acid gases in the background gas, periodic electrolyte changes may be necessary. Contact Delta F for specific maintenance recommendations.
- 5) Avoid using plastic tubing to deliver sample gas to the Analyzer. Stainless steel tubing is recommended for all applications, however copper tubing is acceptable for high trace and percent applications. If plastic tubing is to be used, to permit a flexible connection, carefully strain relief the tubing connection points.
- 6) Never use a graphite pencil to manipulate a DIP switch. Graphite is a conductive powder that may contaminate the circuit board.
- 7) Avoid exceeding 5 psig back pressure on the sensor (determined by sample outlet flow restrictions, such as vent flare lines) and 5 scfh sample flow under both transient and steady state conditions.
- 8) The electronics and oxygen sensor are calibrated as a pair. Sensor calibration information and the instrument serial number are stored in a non-volatile memory on the Main Board. As such, sensors and Main boards should not be swapped between instruments without consulting the Delta F Customer Support Services Department for assistance at 781-935-5808.

3.0 Beyond The Basic Analyzer - The Options

Many options are available with the Analyzer at the time of purchase. Some options can be retrofitted in the field. If the Analyzer has options, this section will describe their setup.

Note: To determine whether a particular option is installed, check the Analyzer Configuration Card located in the pocket inside the front door of the Analyzer, or the packing list. For all software and some hardware options it is possible to determine the presence of an option via the menus. If the Analyzer is not equipped with the option the display will show an "NA" (**Not Available**) designation beside the menu item.

The Analyzer has four slots for printed circuit boards; one large slot at the top and three small slots below. The large slot at the top holds the Main Board which handles Signal Processing and Control. The upper-most small slot holds the Analog Output PCB. The small slot at the bottom holds the Power Supply Board. The unused middle slot is reserved for future options.

CAUTION



The rear connector on both the Power Supply and Analog Output Board is equipped with a key that prevents plugging each board into the other board's slot. The Power Supply Board is installed in the bottom slot.

Set-up procedures for the following options can be found in the listed Section.

Option Description	Section	Option Part Number
High-Resolution Model	3.1	Model # starts: FAH or PAH
STAB-EL	3.2	'S' in position 8 of Model #
Pump	3.3	PT-P014
Heater	3.4	PT-T100
Filter	3.5	PT-F2S

(Continued)

(Continued From Previous Page)

Option	Section	Option Part Number
Regulator	3.6	PT-PRI-5 or PRA-0
Filter & Regulator	3.7	PT-F2S & PT-PRI-5
Supplemental Ni-Cd Battery Power	3.8	PT-NICAD
Key Lock	3.9	PT-KYLK
Stainless Steel Outlet Line	3.10	PT-SSOL
Welded Gas Delivery System	3.11	PT-PVSR
4-20 mA Fully Isolated Output	3.12	PT-4-20I
Quick Start	3.13	PT-Q01
Password Protection	3.14	PT-PASS
Gas Scale Factor	3.15	PT-Y04
Alarms	3.16	
Oxygen Alarms	3.16.1	PT-M002, PT-M004
Temperature Alarm	3.16.2	PT-TALM
Flow Alarm	3.16.3	PT-FALM
Electrolyte Alarm	3.16.4	PT-Q08
Expanded Range Scale Output	3.17	PT-ERS-OUT
Relay Contact Closures	3.18	PT-RLY1 thru PT-RLY4
Panel/Rack Mount	3.19	PT-PNL or PT-RMNT
Comm Ports	3.20	PT-RS232 or PT-RS485
CE Conformance	*	PT-CE
Model FAH0050 With M Series Sensor	*	FAH0050
Nitrogen Case Purge	*	PT-N2CP-FS

* An addendum is bound in the front of the manual if this option is installed.

3.1 High-Resolution Model

The High-Resolution Analyzer offers extended capabilities at the lower end of the range. Table 3-1 lists the extended capabilities of the High-Resolution Analyzer compared to the standard unit. The High-Resolution Analyzer automatically changes between scales A and B to provide increased resolution at the lower end of the instrument range. The standard Analyzer operates only on scale B (which extends down to 0 ppm or 0%).

Table 3-1
Instrument Resolution

Instrument Range	Scale A	Display	Scale B	Display
<i>(Trace - all units in ppm)</i>				
0 - 50	0 - 2.5	X.XXX	2.5 - 50	XX.XX
0 - 100	0 - 10	XX.XX	10 - 100	XXX.X
0 - 500	0 - 50	XX.X	50-500	XXX.
0 - 1000	0 - 100	XXX.X	100 - 1000	XXXX.
0 - 5000	0 - 500	XXX.	500 - 5000	XXXX.
0 - 10000	0 - 1000	XXXX.	1000 - 10000	XXXXX.
<i>(Percent - all units in %)</i>				
0 - 5	0 - 0.5	.XXX	0.5 - 5	X.XX
0 - 10	0 - 1	X.XXX	1 - 10	XX.XX
0 - 25	0 - 2.5	X.XX	2.5 - 25	XX.X

3.2 STAB-EL

With the STAB-EL option, oxygen measurements can be made in sample gas streams that contain acid gas components. The STAB-EL system removes harmful anionic species and minimizes back diffusion of the species into the sensor cavity. A complete discussion of the STAB-EL system is given in Section 7.2.

CAUTION



An Analyzer that has "-V6" in its serial number cannot be used in applications with acid gases.

3.3 Pump

Three optional internal pumps are available: 120 VAC, 220 VAC and 6 VDC. The pump draws the sample gas through the sensor. The DC pump has a brushless motor for long life. Pumps are controlled from the front panel keyboard. All three pumps require about 5 Watts of power.

CAUTION



Analyzers with a pump are fitted with a valve on the rotameter (downstream of the sensor) and a valve on the sensor inlet (upstream of the sensor). When using a pump to draw a gas sample at less than 0.2 psig, the downstream rotameter valve is used as the flow control valve. The sensor inlet (upstream) valve is shipped from the factory in the fully opened (counter-clockwise) position. Its position should not be changed unless the Analyzer is operated on positive pressure, e.g., when measuring a sample greater than 0.2 psig (but less than the maximum limit of 10 psig) that is vented to atmosphere. Likewise, when operating with a positive pressure the rotameter (downstream) valve should be fully opened and the upstream flow control valve used for flow control. **FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE THE SENSOR TO EXPERIENCE OVER OR UNDER PRESSURE WHICH MAY CAUSE PERMANENT DAMAGE NOT COVERED BY THE WARRANTY.**

A pump may be used, when the gas sample is under slight positive pressure, to provide sufficient pressure differential to maintain flow. Also, a pump will be useful if there is some slight back pressure at the Analyzer outlet, such as may be caused by an analyzer vent or sample return line. See Section 5.1, Sample Flow Rate And Pressure, for a discussion of both positive and negative pressure operation.

Calibration procedures may be different for Analyzers equipped with a pump versus those without a pump. Section 6.4.5.2 describes both procedures.

Figure 3-1 shows various plumbing configurations with different options: basic Analyzer (a), optional pump and flow switch (b), optional welded inlet plumbing with metal face-seals (c), and optional welded inlet plumbing with metal face-seals, flow switch and pump (d).

3.4 Heater

No internal heater option is available for the Analyzer. The heater ON/OFF capability found in the CONTROL menu is used to switch power to an optional heater in the R4 or R7 remote sensor enclosure configuration. If sensor temperature exceeds 45°C the heater will automatically turn off.

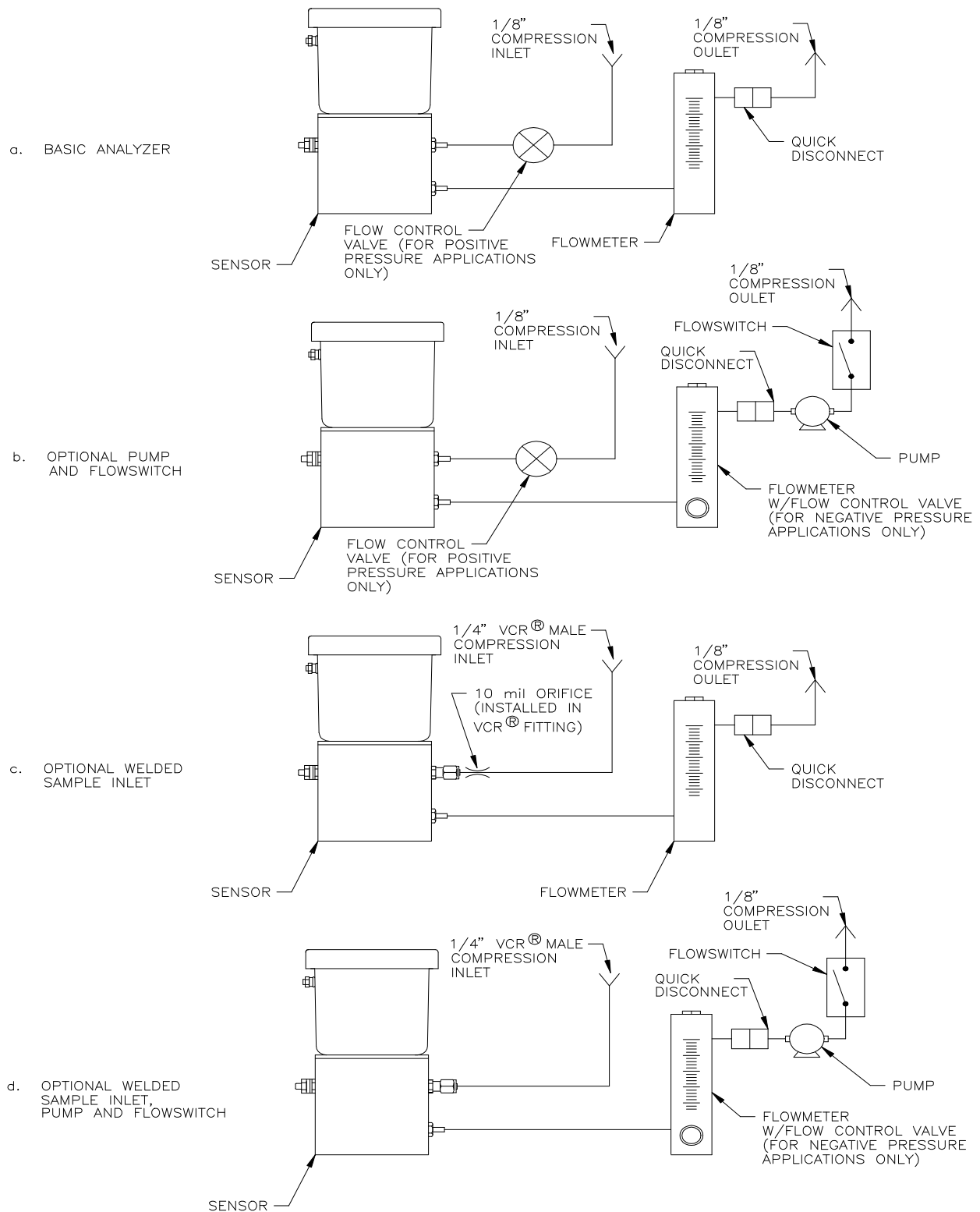


FIGURE 3 - 1 PLUMBING CONFIGURATIONS

3.5 Installation Of The Filter

The filter assembly is installed at the factory when ordered with the Analyzer. However, a filter assembly may be purchased later and installed by the user. It is mounted externally on the upper right corner of the back panel as shown in Figure 3-2. The option includes a preformed tube with fittings to connect the filter outlet to the Analyzer inlet. The back panel of the Analyzer has three PEM nuts for mounting the filter bracket. Use the screws supplied with the PEM nuts.

Note: The filter has two ports labeled 1 and 2. For particulate removal plumb the filter with port 2 connected to the Analyzer's sample inlet fitting. For mist coalescing and collection for draining, plumb the filter with port 1 connected to the Analyzer's sample inlet fitting.

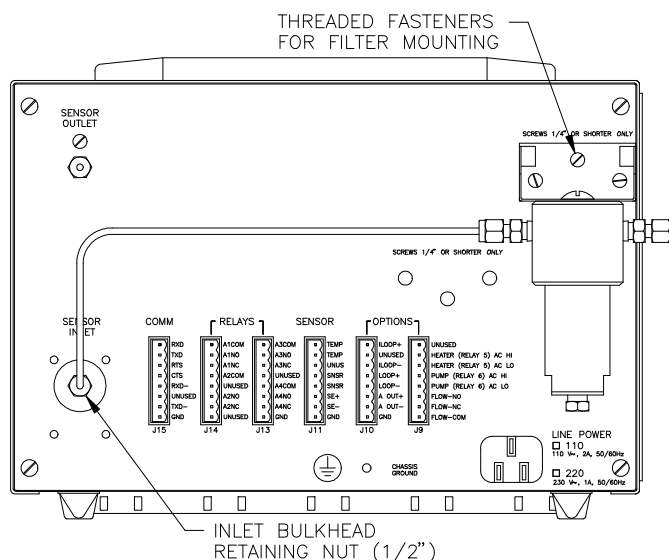


FIGURE 3-2 FILTER INSTALLATION

DANGER



It is very important to use the supplied screws to mount the bracket (or their equivalent - steel pan head 10-32 by 1/4" long). Longer screws will damage the backplane PCB.

Two grades of filter elements are available for the filter:

- | | |
|--------------------------------|--------------|
| Fine grade (BQ) (< 1 micron) | P/N 64005012 |
| Course grade (DQ) (> 1 micron) | P/N 64005011 |

The course grade is normally supplied. Section 8.1.4 discusses filter maintenance.

3.6 Installation Of The Pressure Regulator

The gas pressure regulator is installed at the factory when ordered with the Analyzer. However, a gas pressure regulator may be purchased later and installed by the user. It is mounted on the back panel as shown in Figure 3-3. The option also includes a preformed tube with fittings to connect the regulator outlet to the Analyzer inlet. The back panel of the Analyzer has three PEM nuts for mounting the regulator bracket. Use the supplied screws with the PEM nuts.

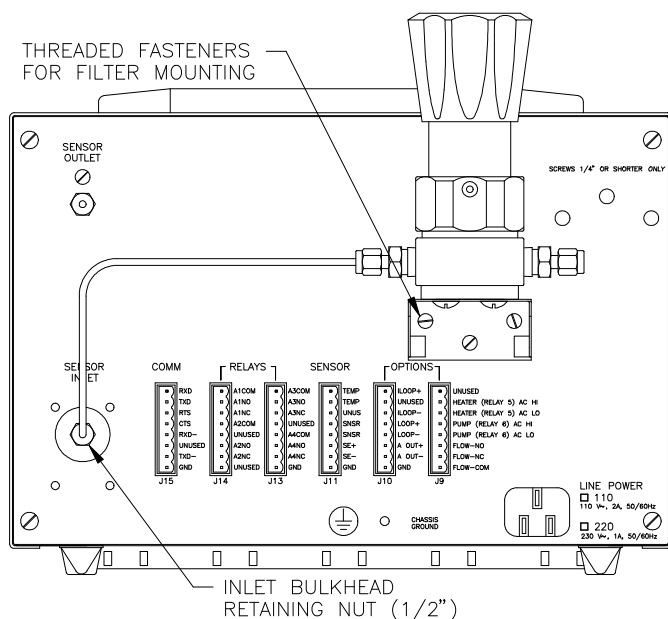


FIGURE 3-3 REGULATOR INSTALLATION

DANGER



It is very important to use the supplied screws to mount the bracket (or their equivalent - steel pan head 10-32 by 1/4" long). Longer screws will damage the backplane PCB.

3.7 Installation Of Both Filter And Pressure Regulator

The gas filter and regulator are installed by the factory when ordered with the Analyzer. However, the gas filter and regulator may be ordered later and installed by the user. They are supplied as a unit with one mounting bracket and mounting screws. The option also includes a preformed tube with fittings to connect the regulator outlet to the Analyzer inlet. These should be mounted on the back panel as shown in Figure 3-4 using the supplied screws.

Note: The filter has two ports labeled 1 and 2. For particulate removal plumb the filter with port 2 connected to the Analyzer's sample inlet fitting. For mist coalescing and collection for draining, plumb the filter with port 1 connected to the Analyzer's sample inlet fitting.

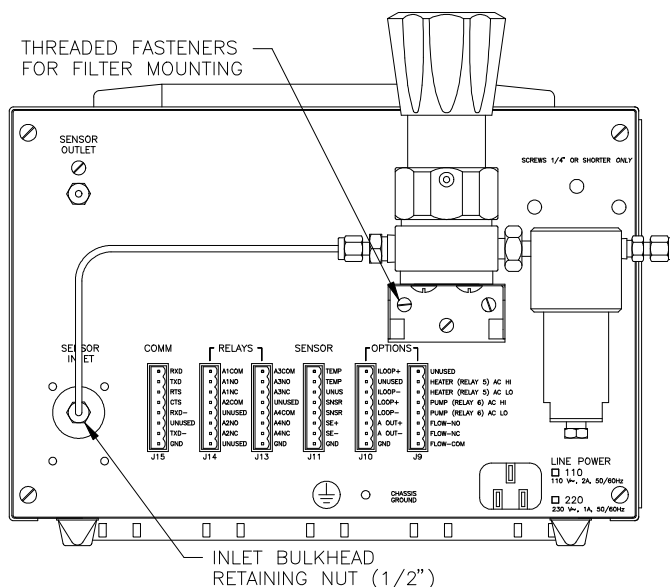


FIGURE 3-4 FILTER AND REGULATOR INSTALLATION

DANGER



It is very important to use the supplied screws to mount the bracket (or their equivalent - steel pan head 10-32 by 1/4" long). Longer screws will damage the backplane PCB.

3.8 Supplemental Ni-Cd Battery Power

Analyzers equipped with this option have a nickel-cadmium battery pack to provide backup battery power for up to eight hours. Operation with a pump reduces operating time to about four hours. Operating time, when using a pump, is somewhat dependent on the pump inlet to outlet differential pressure; the larger the difference the more power consumed.

Charging occurs only while the Analyzer is connected to AC power with the power switch turned on. The batteries can be charged while the Instrument is not in service by leaving the power switch on and turning off power to the sensor. See Section 6.3.4 for details. A thermal switch in the battery pack will turn off battery charge current at $45 \pm 5^{\circ}\text{C}$ to protect the batteries from overheating.

Approximately 15 hours are required to charge a battery pack fully when the optional pump is not operating. With an operating pump, a full charge will require approximately 24 hours of operation on AC power. The charger PCB is mounted on the wall of the card cage, to the left of the sensor. It has two LEDs: the top LED (red) indicates operation on batteries, the lower LED (green) indicates that the battery charger is operating at the high charge rate. When the battery is fully charged the charger automatically switches to a trickle charge rate.

The annunciator line in the Analyzer's display (Figure 6-1) indicates low battery power by displaying "[**BAT LOW**]." When the BAT LOW signal is displayed, about 1 hour of operating time remains.

The Analyzer with the battery pack option uses less than 35 Watts of AC power. If the unit is equipped with a pump the power consumption is 40 Watts.

3.9 Key Lock

An optional key lock can be installed in the door of the Analyzer to prevent access to the power switch and other internal components. The lock is supplied with two keys.

If the Analyzer is operating, the key lock will not prevent adjustments from the front panel. Optional Password Protection, described below, must be used to lock-out front panel control changes.

3.10 Stainless Steel Outlet Line

Analyzers equipped with the stainless steel outlet line option do not have a pump. Because of the rigid outlet tube, the Sensor Assembly can only be removed after both inlet and outlet bulkhead hex nuts (1/2") and washers are removed. When reinstalling the sensor, make sure both bulkhead fittings are oriented with the hex section flats horizontal. The flat sides of the fitting will seat in the retainer blocks on the inside rear of the enclosure.

3.11 Welded Gas Delivery System With VCR[®] Metal Face-Seal Inlet Connections

The optional welded gas delivery system, with metal face-seal inlet connections, is standard on the 0-50 ppm high resolution instrument, model number FAH0050.

This option incorporates welded 1/4 inch tubing with a male VCR[®] compatible metal-face seal connection fitting at the inlet and a 1/8 inch compression fitting at the outlet. The option does not have an inlet flow control valve.

The outlet sample line will have a rotameter with a flow control valve. An optional flow switch and/or pump may also be used. Vinyl tubing is used to connect all components in the sample outlet line, unless also equipped with the Stainless Steel Outlet Line option.

Tools required to remove the sensor tray include a 3/4" open end wrench for the VCR[®] nut, and a 13/16" open end wrench for the bulkhead nut. Mounting a VCR[®] regulator also requires a 5/8" open end wrench to backup a fitting while tightening the VCR[®] nut. To remove the Sensor Assembly, turn the power switch to the off position, remove only the sample inlet bulkhead nut at the back of the Analyzer (requires a 13/16" wrench), unplug the sensor cable, loosen both thumb-screws at the sensor base and withdraw the Sensor Assembly to gain access to the quick disconnect fitting at the top of the rotameter. See Figure 2-1 for details. Disconnect the fitting by pushing both halves of the fitting together and rotating one to the disengaged position, then pull apart. Remove the Sensor Assembly.

See Section 3.10 for sensor removal instructions if equipped with the Stainless Steel Outlet Line option.

Metal face-seal installations require very high purity regulators, upstream (bellows) valves, and welded sample lines leading up to the Analyzer. Gas conditioning systems are available from Delta F in custom configurations. Consult the Delta F Customer Support Services Department for more information, and recommendations, at 781-935-5808.

Note: Analyzers with a metal-face seal inlet, and without a pump, have a 10 mil orifice at the sensor inlet fitting in place of the usual metal gasket. This orifice is Delta F Part Number 16317340. Analyzers with a metal-face seal inlet and a downstream pump (Part Number PT-P014), or those ordered with an orifice deleted, use a standard face seal gasket at the sensor sample inlet. This standard gasket is Delta F Part Number 60300241. The orifice is in the VCR® fitting directly on the sensor inlet. The presence of the orifice is indicated by a clear tape label, marked '.010" Orifice', wrapped around the female VCR nut on the sensor inlet. This fitting will not have to be disconnected to remove the sensor plumbing assembly for electrolyte changes. In fact, there are no normal service operations that will require the sensor inlet fitting to ever be disconnected.

The orifice is sized to provide approximately 2.0 scfh at an Analyzer pressure of 15 psig when the Analyzer outlet is vented to atmosphere. Delta F recommends using a high-integrity valve (bellows type) or pressure regulator on the inlet line to control the flow rate and to provide isolation capability. If the line pressure exceeds 20 psig, use a pressure regulator.

If the Analyzer outlet is at atmospheric pressure, the regulator can be used to set the flow rate at the nominal 2.0 scfh without danger of over-pressurizing the sensor. The back pressure on the sensor should not exceed ± 5.0 psig. In those applications where the Analyzer is venting into a common vent or flare system it is recommended that back pressure be measured to ensure that it is within acceptable limits.

If reconnecting the plumbing at the sensor fitting, be sure to install a new face seal gasket of the proper type. Spare sensors will be supplied with a new orifice type gasket.

3.12 4-20 mA Fully Isolated Output

The Analyzer can be equipped with an optional 4-20 mA output which is completely isolated from all other analog outputs and earth ground. An internal 15 VDC compliance voltage is provided. Maximum loop resistance is 550 Ohms.

Connections are made at pin J10-1 (ILOOP+) and J10-3 (ILOOP-) at the back of the instrument. See Figure 2-2 for details. Analyzers equipped with this option also have the standard 4-20 mA non-isolated output.

3.13 Quick Start

The Quick Start feature is used to assist the Analyzer in making oxygen readings, at low ppm values, more quickly. It may be used when the Analyzer is first turned on to decrease the time to reach equilibrium, especially with sample gases below 100 ppm. Section 6.3.1 provides additional information about Quick Start.

3.14 Password Protection

The optional password protection feature is used to limit access to the Control Menu, the Set-Up Menu, and the Diagnostics Menu. Password protection has two levels: A Master Password and an Operator Password. The Master Password is required to edit the password menu. The holder of the master password sets the password requirement for other menus. Section 6.5 has a full discussion on the use and features of Password Protection.

3.15 Gas Scale Factor

The optional GSF (Gas Scale Factor) is used to correct for changes in the rate of oxygen diffusion when background gases other than nitrogen are present in the sample gas. The GSF will be calculated by the microprocessor automatically when the user selects the appropriate gas composition from the menu provided. Alternatively, the GSF number can be calculated and entered manually. See Section 6.4.5.1 for details.

3.16 Alarms

The Analyzer can be equipped with up to seven alarms. These alarms can be user-controlled to activate up to four optional relays. High and low set-points and deadbands are user adjustable. An audible annunciation can be set to occur when each alarm condition is detected. This annunciation may be silenced by the operator. Section 6.4.1 provides detailed information about setting and using the Alarms.

3.16.1 Oxygen Alarms

The Platinum Series Process Oxygen Analyzer can be equipped with up to four oxygen alarms. Each alarm has a Hi and Lo set point and deadband that are selected by the user. See Section 6.4.1.1.

3.16.2 Temperature Alarm

The temperature alarm is used to indicate an out of specification temperature condition for the sensor. Temperature is measured by a solid state device that is mounted in the core of the Oxygen sensor. The alarm has a high and low set point and deadband which are user-set. The maximum temperature setting is limited to 45°C. See Section 6.4.1.2.

3.16.3 Low Flow Alarm

An optional low flow alarm is available. Low flow is detected by a flow switch which is located inside the enclosure on the right side. The switch inlet gas connection is connected to the outlet of the rotameter. Switch contacts opens when flow drops below 0.25 scfh (for nitrogen), which signals the Analyzer to alarm. See Section 6.4.1.3 for details. The flow alarm can be used to control an optional alarm relay.

3.16.4 Electrolyte Condition Alarm

The electrolyte alarm is used to indicate the condition of the electrolyte. The alarm will sound if the electrolyte level is low, or in some cases, if the electrolyte is contaminated. See Section 6.4.1.4. If the electrolyte level is low, add deionized or distilled water up to the MAX line, per Section 8.1.3. Within one minute the alarm should clear. If the alarm does not clear, see Section 8.2, Troubleshooting.

3.17 Expanded Range Scale Output

The expanded range scale option allows the analog output scaling to be automatically expanded when the normal scaling range is exceeded. For example: On a 0-500 ppm instrument the analog outputs may be set so that 0-10 VDC, and 4-20 mA, are scaled over 0-10 ppm. This means that the analog outputs will peg if the concentration exceeds 10 ppm. The expanded range scale function allows a second, larger, range scaling to become active when the Analyzer reaches 10 ppm. For example, it may be desired to set the expanded range at 500 ppm so that the analog outputs can operate up to the full scale limit of the Analyzer. The instrument will switch back to the 0-10 ppm scaling when the oxygen value falls below 95% of 10 ppm. An alarm relay may be assigned to indicate when the expanded range is in effect. See Section 6.4.2.2 for details.

3.18 Relay Contact Closures

Up to four optional form C (SPDT) relays (contact closures) are available. The contacts are rated 5 amps @ 120/240 VAC and 30 VDC under a resistive load. Relay contacts can be assigned to any of the up to seven Alarm signals, Analyzer IN-CAL, Sensor OFF, or optional Expanded Range status indicators. Pin assignments are shown in Figure 2-2. Section 4.3 provides relay connection details. All relay contacts switch into the Alarm position when power is lost or turned off.

3.19 Panel/Rack Mount

A panel mount and a 19" rack mount are available for the Analyzer. The panel mount requires a cut-out for installation. Figures 3-5, 3-6 and 3-7 show the rack and panel mounts and the cut-out for the panel. The panel mount installs from the front.

3.20 Comm Ports

Either of two communication ports are available at time of order: RS-232 or RS-485. A command set reference document is available to allow customers to write software to interface the Analyzer to their computers. Contact the Delta F Customer Support Services Department, at 781-935-5808, for more information. See Section 4.2 for port connection details and Section 6.4.3 for port setup information.

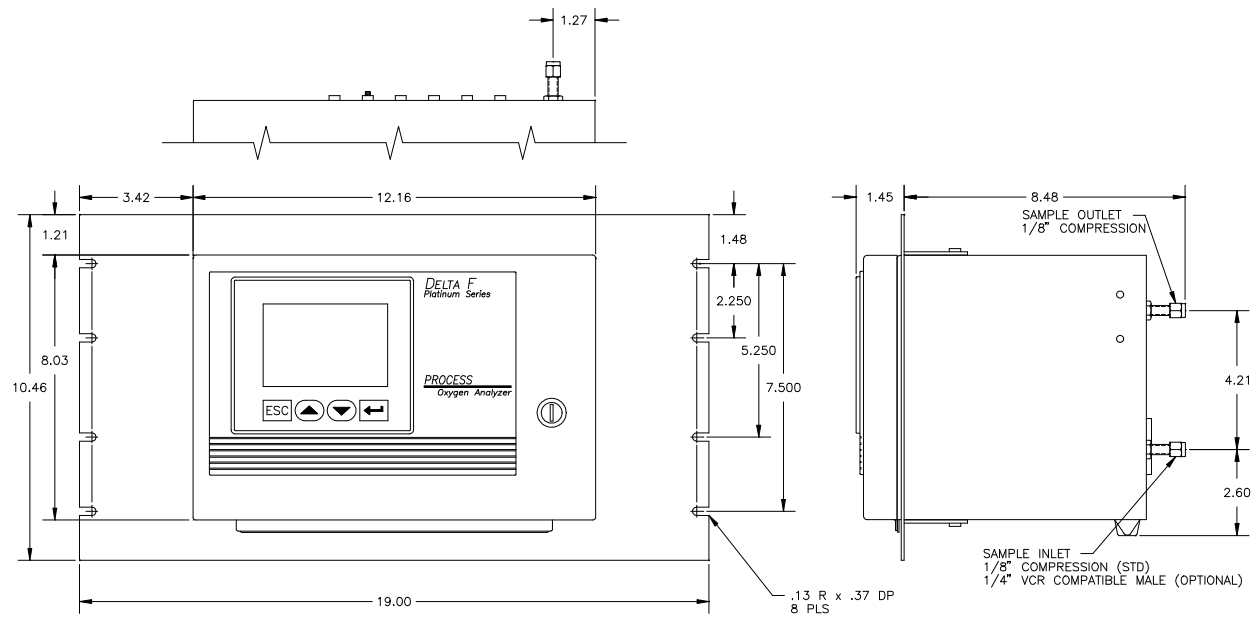


FIGURE 3-5 RACK MOUNT CONFIGURATION

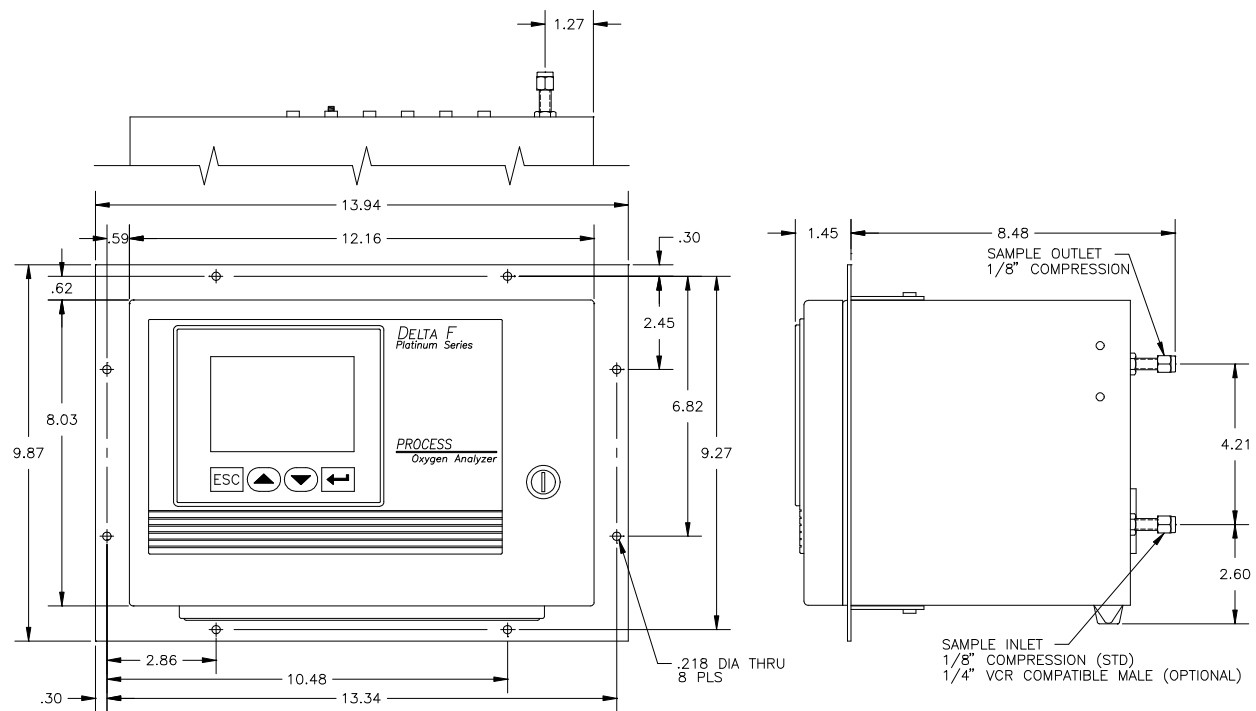


FIGURE 3-6 PANEL MOUNT CONFIGURATION

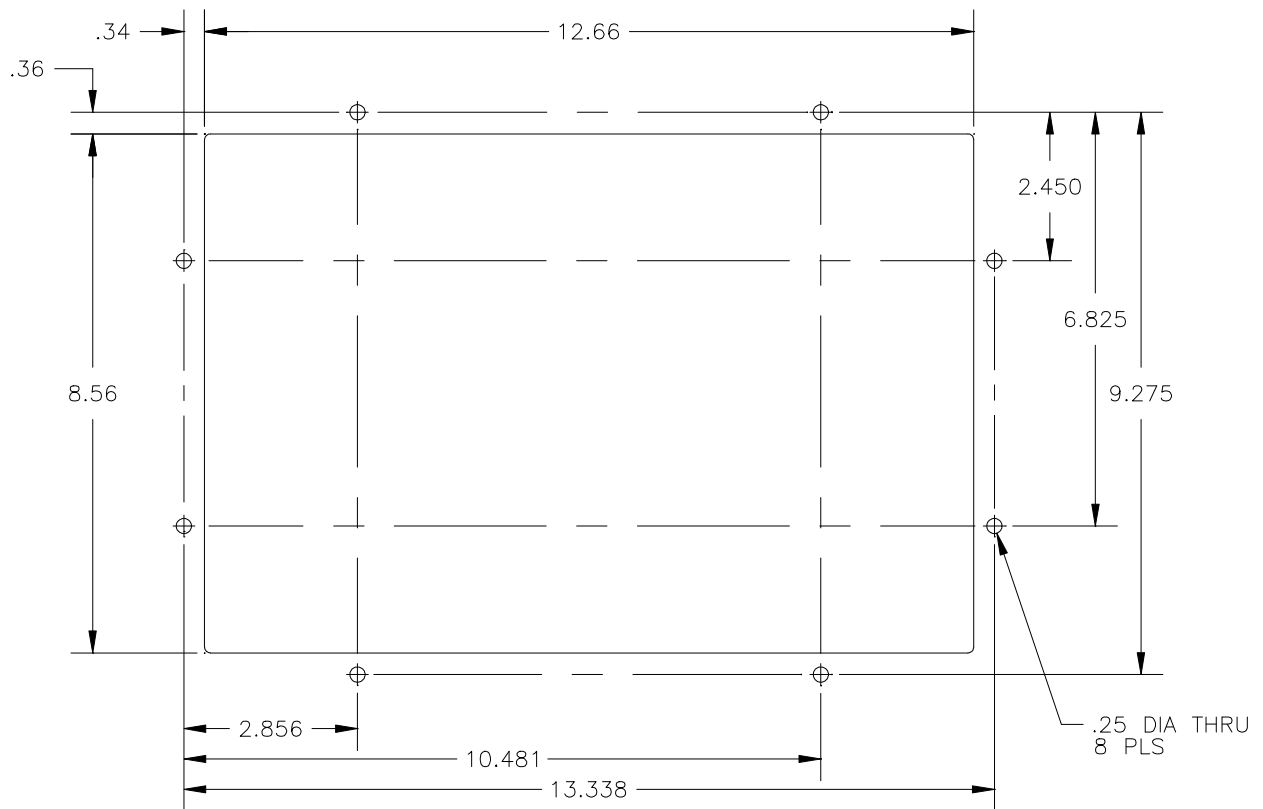


FIGURE 3-7 CUTOUT DIMENSIONS FOR PANEL MOUNT

4.0 Connecting To External Devices

4.1 Introduction

The Platinum Series Process Oxygen Analyzer can be interfaced to a variety of external devices via the ports on the rear panel (see Figure 2-2). Alarm relay contacts, voltage and current outputs, serial communication, and a remote sensor interface are all supported. For each port a list is provided of other manual sections that discuss signal levels, user interface settings, and special functions related to that port. Section 4.7 discusses signal output grounding issues, and cable shielding requirements.

4.2 The Comm Port

The optional Comm port is used for communication via the RS-232C or the RS-485 protocol. Protocol selection must be made at time of order, because (among other changes) different interface chips are used for each protocol. Up to 32 units may be accessed via RS-485. Operating parameters are 8 bits, no parity, and one stop bit. Baud rate may be selected from the front panel; refer to Section 6.4.3. Data format is a custom binary packet-based request/response protocol. A command set reference is available to allow programmers to create their own interface program for accessing the communication port. Section 4.7 discusses comm port output grounding issues, and cable shielding requirements.

Further information related to the communications port may be found in the following sections:

Subject	See For Further Details
User Interface Settings	Section 6.4.3

The Comm Port (J15) terminals are defined as follows:

J15-1	RXD	Data received by the Analyzer from the device (RS-232 or RS-485)
J15-2	TXD	Data transmitted from the Analyzer to the device (RS-232 or RS-485)
J15-3	RTS	Request to Send (Not Used)
J15-4	CTS	Clear to Send (Not Used)
J15-5	RXD-	4 wire RS-485 Received Data (Paired with RXD)
J15-6	UNUSED	Key
J15-7	TXD-	4 wire RS-485 Transmitted Data (Paired with TXD)
J15-8	GND	Ground (Analyzer DC Ground)

CAUTION



To avoid ground-loop conflicts when using RS-232C or RS-485 for communications, make connections to other equipment such as external recorders or data acquisition systems through a differential input, or a single ended input that is NOT referenced to earth. See section 4.7 for more information.

Note: Using the optional Isolated 4-20 mA output avoids the ground-loop conflict.

4.3 Relay Ports

Four optional form C (SPDT) relays (contact closures) are provided on the Platinum Series Process Oxygen Analyzer. These are used in conjunction with up to seven optional programmable alarms, and three status conditions. The contacts are rated at 5 amps @ 120/240 VAC and 30 VDC under a resistive load. Section 4.7 discusses relay contact output shielding requirements.

The relay ports can be programmed for the following alarms and status conditions:

Subject	See For Further Details
Oxygen (total of 4 alarms)	Section 6.4.1.1
Temperature Alarm	Section 6.4.1.2
Flow Alarm	Section 6.4.1.3
Electrolyte Condition Alarm	Section 6.4.1.4
Sensor Off Status	Section 6.3.4
Expanded Range Status	Section 6.4.2.2
In-Calibration Status	Section 6.4.2.5

Note: Some of the above alarms or status conditions are options that may or may not be available on a particular Analyzer.

A relay can be assigned to any alarm or alarms as described in Section 6.4.1.

Relay nomenclature defines "Normal" as the "No Alarm" condition. The Normally Open contact connects to common when an alarm occurs or power to the instrument is lost.

The Relay Ports (J14 and J13) terminals are defined as follows:

J14-1	A1COM	Relay 1 Common
J14-2	A1NO	Relay 1 Normally Open
J14-3	A1NC	Relay 1 Normally Closed
J14-4	A2COM	Relay 2 Common
J14-5	UNUSED	Key
J14-6	A2NO	Relay 2 Normally Open
J14-7	A2NC	Relay 2 Normally Closed
J14-8	UNUSED	
J13-1	A3COM	Relay 3 Common
J13-2	A3NO	Alarm 3 Normally Open
J13-3	A3NC	Alarm 3 Normally Closed
J13-4	UNUSED	Key
J13-5	A4COM	Relay 4 Common
J13-6	A4NO	Relay 4 Normally Open
J13-7	A4NC	Relay 4 Normally Closed
J13-8	GND	Ground (Analyzer DC Ground)

4.4 Sensor Port

Further information related to the sensor port may be found in the following sections:

Subject	See For Further Details
Sensor ON/OFF	Section 6.3.4
Sensor Protection	Section 6.3.4
Temperature Over Range	Section 6.2
Temperature Alarm	Section 6.4.1.2
Electrolyte Condition Alarm	Section 6.4.1.4

The Sensor Port (J11) connects a remote sensor to the electronics. The sensor port terminals are defined as follows:

J11-1	TEMP+	Temperature Sensor +
J11-2	TEMP-	Temperature Sensor -
J11-3	UNUSED	Key
J11-4	SNSR+	Oxygen Sensor +

(Continued On Next page)

(Continued From Previous Page)

J11-5	SNSR-	Oxygen Sensor -
J11-6	SE+	Secondary Electrode +
J11-7	SE-	Secondary Electrode -
J11-8	GND	Ground (Analyzer DC Ground)

4.5 Option Ports

Two option port connectors, J10 and J9, are provided. Connector J10 is used for interfacing to an analog recorder (0-0.1 VDC, 0-1 VDC, 0-5 VDC, or 0-10 VDC, see Section 4.6) and driving two 4-20 mA loops. Connector J9 is used for connecting the optional heater and pump when the sensor is remotely located. Section 4.7 discusses signal output grounding issues, and cable shielding requirements.

NOTE: Alarm or Analyzer status conditions that signal an “Analyzer off-line” fault condition (such as sensor off) can be assigned to a single relay contact used as a trouble indicator. If the Analyzer signal is only monitored remotely, it is suggested to route the 4-20 mADC signal through the “Analyzer Trouble” relay such that an alarm condition will cause the relay to break the current loop. This method allows a computerized system to be configured to detect an analyzer fault condition whenever the 4-20 mADC signal is below 4 mA.

Further information can be found in the following sections for items associated with the analog output signals:

Subject	See For Further Details
Output Scaling	Section 6.4.2
CAL FREEZE	Section 6.4.2.4
Expanded Range	Section 6.4.2.2
Signal Specifications	Section 10

J10 terminals are defined as follows:

J10-1	ILOOP+	Fully isolated 4-20 mA output (+), optional
J10-2	UNUSED	Key

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J10-3	ILOOP-	Fully isolated 4-20 mA output (-), optional
J10-4	LOOP+	Standard 4-20 mA output (+)
J10-5	LOOP-	Standard 4-20 mA output (-)
J10-6	A OUT+	Voltage Output + (0-10 VDC Standard, See Section 4.6)
J10-7	A OUT-	Voltage Output - (0-10 VDC Standard, See Section 4.6)
J10-8	GND	Ground (Analyzer DC Ground)

Further information can be found in the following sections for items associated with the heater, pump, and flow switch signals:

Subject	See For Further Details
Heater Control	Section 6.3.3
Automatic Heater Shut Off	Section 6.3.3
Pump Control	Section 6.3.2
Flow Alarm	Section 6.4.1.3

J9 terminals are defined as follows:

J9-1	UNUSED	Key
J9-2	HEATER (RELAY 5) ACHI	Switched AC High to Heater
J9-3	HEATER (RELAY 5) ACLO	AC Low to Heater
J9-4	PUMP (RELAY 6) ACHI	Switched AC High to Pump (Switched Battery Voltage for optional DC pump)
J9-5	PUMP (RELAY 6) ACLO	AC Low to Pump (DC ground for optional DC pump)
J9-6	FLOW-NO	Not Used
J9-7	FLOW-NC	Flow Switch (Opens on Loss Of Flow)
J9-8	GND	Flow Switch Common

4.6 Changing The Analog Voltage Output Selection

The Analyzer is shipped from the factory with the analog voltage output set to 0-10 VDC unless otherwise specified at time of order. However, the user can field-select the analog output to be one of the following: 0-0.1 VDC, 0-1 VDC, 0-5 VDC or 0-10 VDC. To change the voltage output, a digital voltmeter with the following accuracy is required:

RANGE	ACCURACY
0-0.1 VDC	± 0.00001 VDC
0-1.0 VDC	± 0.0001 VDC
0-5.0 VDC	± 0.0006 VDC
0-10 VDC	± 0.001 VDC

- a. Connect the digital voltmeter to J10-6 (A OUT+) and J10-7 (A OUT-).
- b. Open the Analyzer door and turn off the main power switch. Above the power switch is a card cage with three narrow slots and one wide slot. Locate the Analog Output PCB which is the upper of the two smaller boards. See Figure 1-2 for details.
- c. Locate the calibration adjustment potentiometer that is immediately to the right of the 4-position DIP switch at the front edge of the Analog Output PCB.
- d. Each position on the DIP switch is labeled with a full scale voltage selection. Open all of the switches, by placing them in the upward position. Close the desired voltage-output selection switch.

CAUTION



Only one switch should be closed at any time.

CAUTION



To protect the sensor during alignment, ensure that the instrument is sampling from a gas which is within the range of the Analyzer (see Section 2.6), or turn off the sensor polarization voltage using the Controls menu (see Section 6.3.4).

- e. Turn on the Analyzer and temporarily close the door.

- f. When the oxygen display comes up, press the ENTER key to reach the Main Menu. Select **Diagnostics** and then select **Test Output**. Set the desired output level to 100.00%. This will provide a full scale analog output.
- g. Observe the Digital Voltmeter. Using the calibration adjusting potentiometer (located immediately to the right of the DIP switch), adjust the output to within the following limits:

RANGE	SETTING LIMITS
0-0.1 VDC	0.09999 to 0.10001 VDC
0-1.0 VDC	0.9999 to 1.0001 VDC
0-5.0 VDC	4.9994 to 5.0006 VDC
0-10 VDC	9.999 to 10.001 VDC

- h. The Analog Output is now calibrated for the new range.

4.7 Proper Grounding & Cable Shielding For External Equipment

There are two main issues associated with connecting external equipment to the POA:

- 1) Output signal grounding at external equipment.
- 2) Cable shielding and shield terminations.

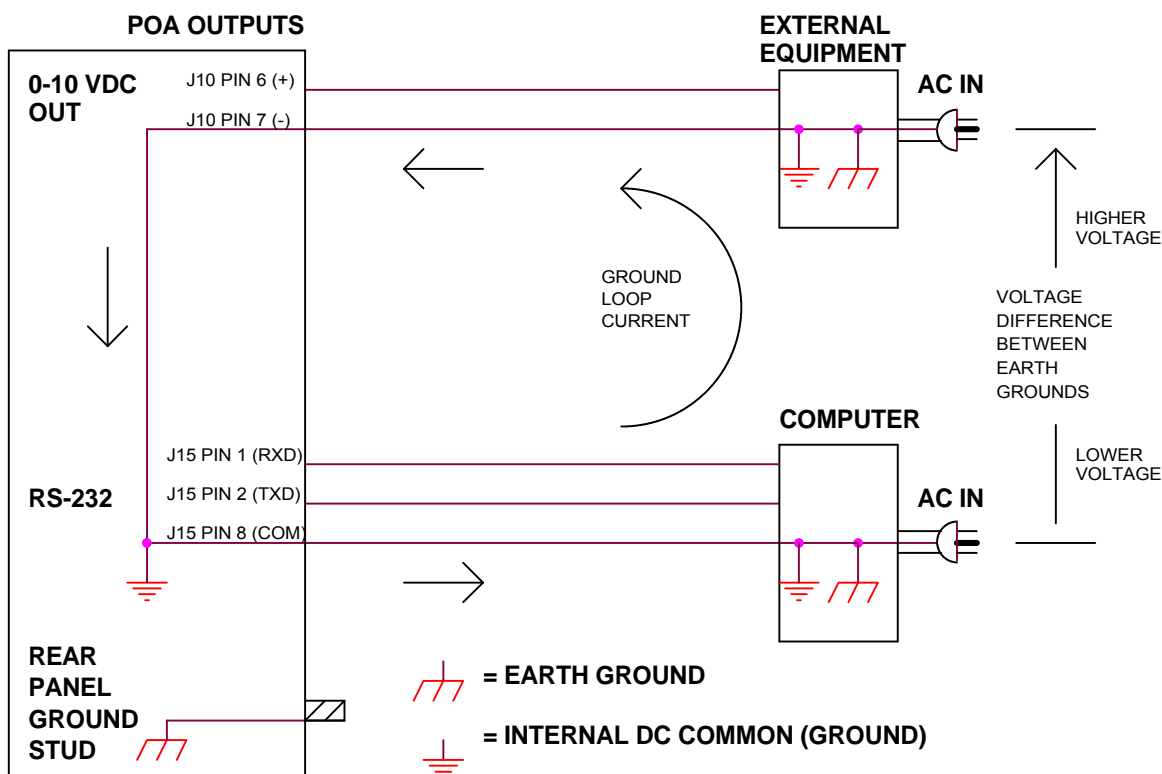
The following sections explain the issues, and then provide specific hook-up examples for various analyzer configurations.

4.7.1 Output Signal Grounding

When connecting external equipment to the POA it is important to identify whether any of the equipment has signal inputs that are connected to earth ground. This is a critical issue because there can be voltage differences, between the different earth grounds, that will cause ground loop currents to flow between the various pieces of equipment. These ground loop currents increase the amount of noise in the system and affect signal accuracy. See Figure 4-1 for an example of a ground loop.

The best way to eliminate the possibility of ground loops is to have only one piece of external equipment connected to the POA. However, if more than one piece of equipment must be connected there are still ways to avoid ground loops, as discussed in later sections.

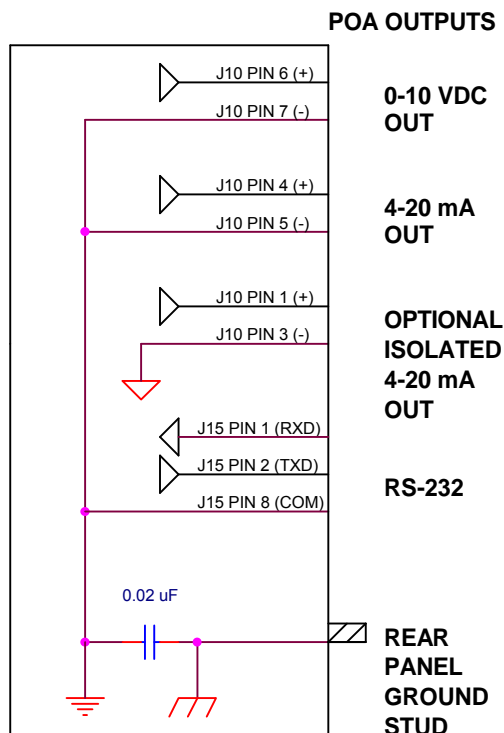
Figure 4-1: Ground Loop Example






As seen in Figure 4-2, all POA outputs share the same common ground, except for the optional 4-20 mA isolated output. This means that ground loops can occur if any two outputs are connected to external equipment that has the same ground (such as earth).

It is certainly possible to use all outputs (0-10 VDC, 4-20 mA, and RS-232/RS-485) as long as each piece of external equipment has a truly isolated input that does not share an internal electrical connection with any other input.

Figure 4-2: Analyzer Internal Grounding



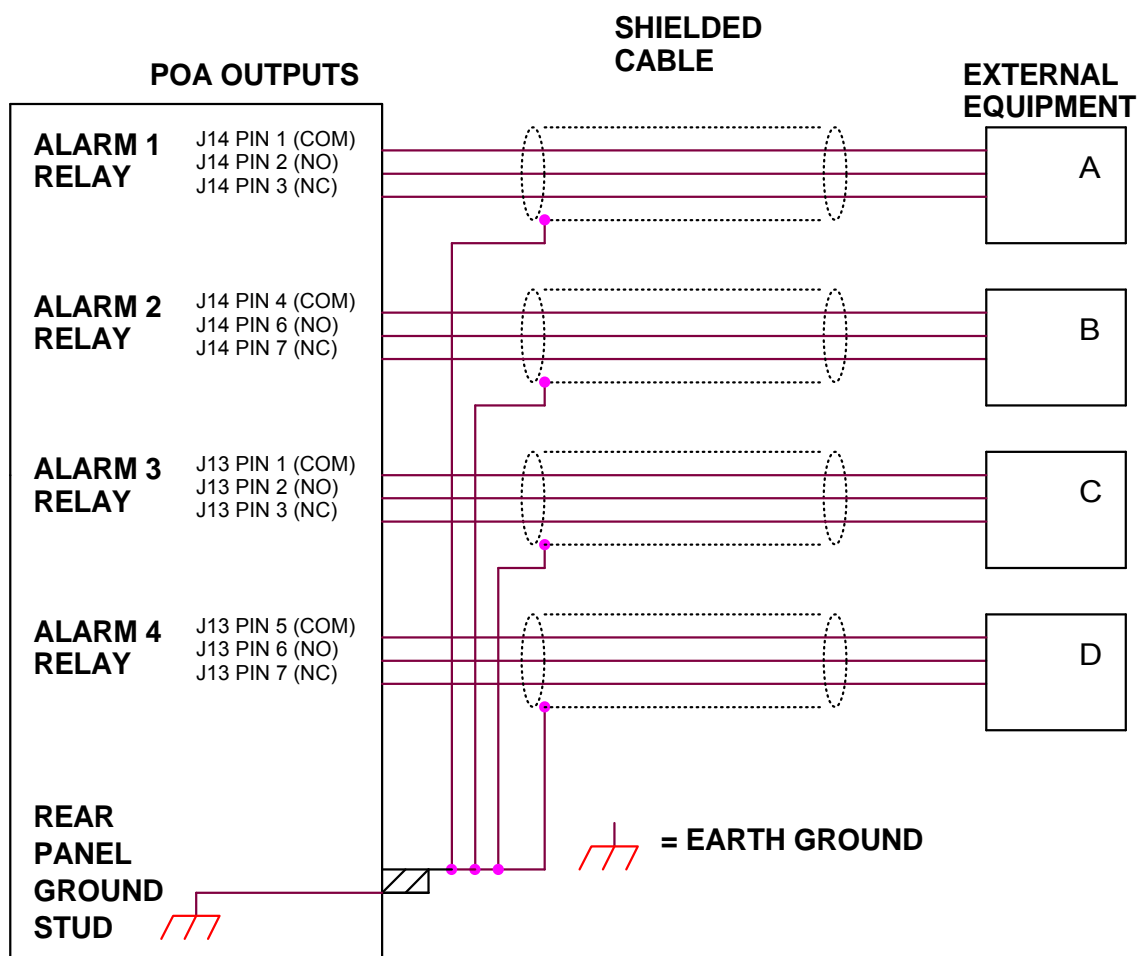
-  = EARTH GROUND
-  = INTERNAL DC COMMON (GROUND)
-  = 4-20 mA COMMON (GROUND)

4.7.2 Cable Shielding

All external cables should be constructed from twisted pair, with an over-all shield. Cables should have their shield connected to the earth ground stud on the rear panel of the analyzer. It is permissible to bundle the output signals from the 0-10 VDC and 4-20 mA outputs into one cable. Do not bundle the RS-232 or RS-485 digital signals with the 0-10 VDC or 4-20 mA analog outputs. Similarly, alarm relay contacts should not be bundled with either digital or analog outputs.

Shielding details for the analog and digital outputs are shown in each of the hook-up drawings in Section 4.7.3. Shielding information for the alarm contacts is provided in Figure 4-3.

Figure 4-3: Analyzer With Relay Outputs



Relay output cables should be constructed from shielded multiconductor cable. This drawing shows individual cables for each relay output, but it is permissible to bundle relay signals into fewer cables.

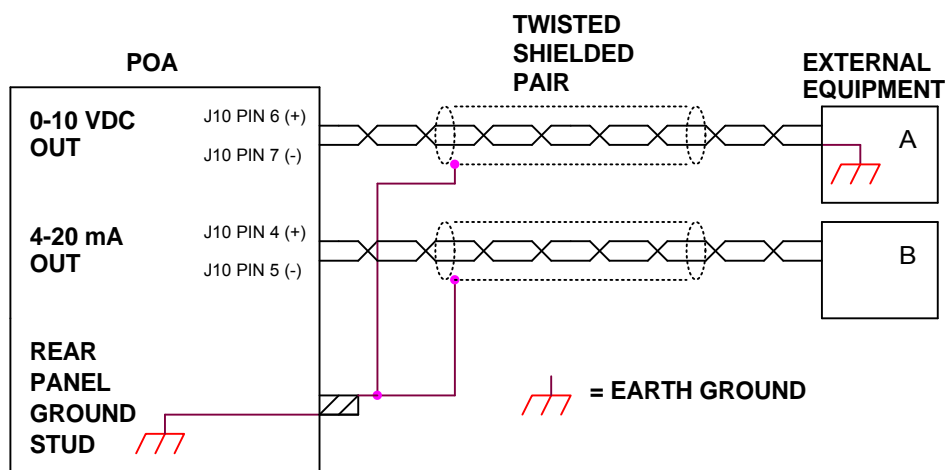
4.7.3 Hook-up For Specific Analyzer Configurations

The following descriptions and figures provide guidelines for hooking up external equipment. Start by determining which output options have been installed in the POA analyzer. Then, refer to the corresponding section, as follows:

Standard analyzer (with no RS-232, RS-485, or isolated 4-20 mA options)	See Section 4.7.3.1
Analyzer with optional 4-20 mA, (with no RS-232 or RS-485 options)	See Section 4.7.3.2
Analyzer with optional RS-232	See Section 4.7.3.3
Analyzer with optional RS-485	See Section 4.7.3.4

4.7.3.1 Standard Analyzer With No RS-232, RS-485, Or Isolated 4-20 mA Options

**Figure 4-4: Standard Analyzer Outputs
(No RS-232, RS-485, Or Isolated 4-20 mA Options)**

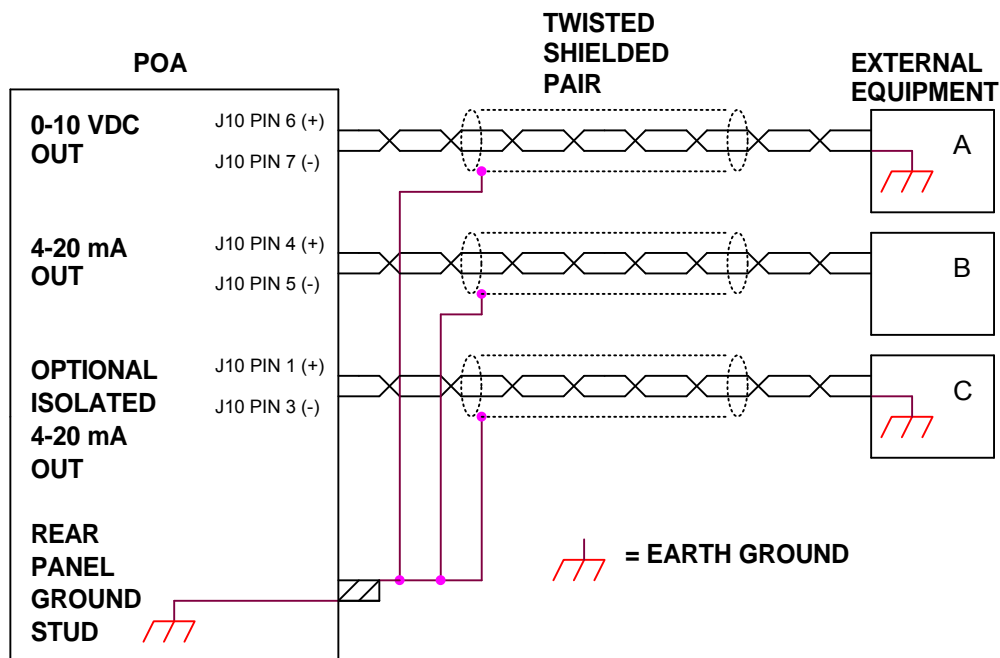


Up to two outputs may be used.

To prevent ground loops, only one piece of equipment (either "A" or "B") may have a signal lead connected to earth ground.

4.7.3.2 Analyzer With Optional 4-20 mA, But No RS-232 Or RS-485

Figure 4-5: Analyzer With Optional Isolated 4-20 mA
(No RS-232 Or RS-485 Option)



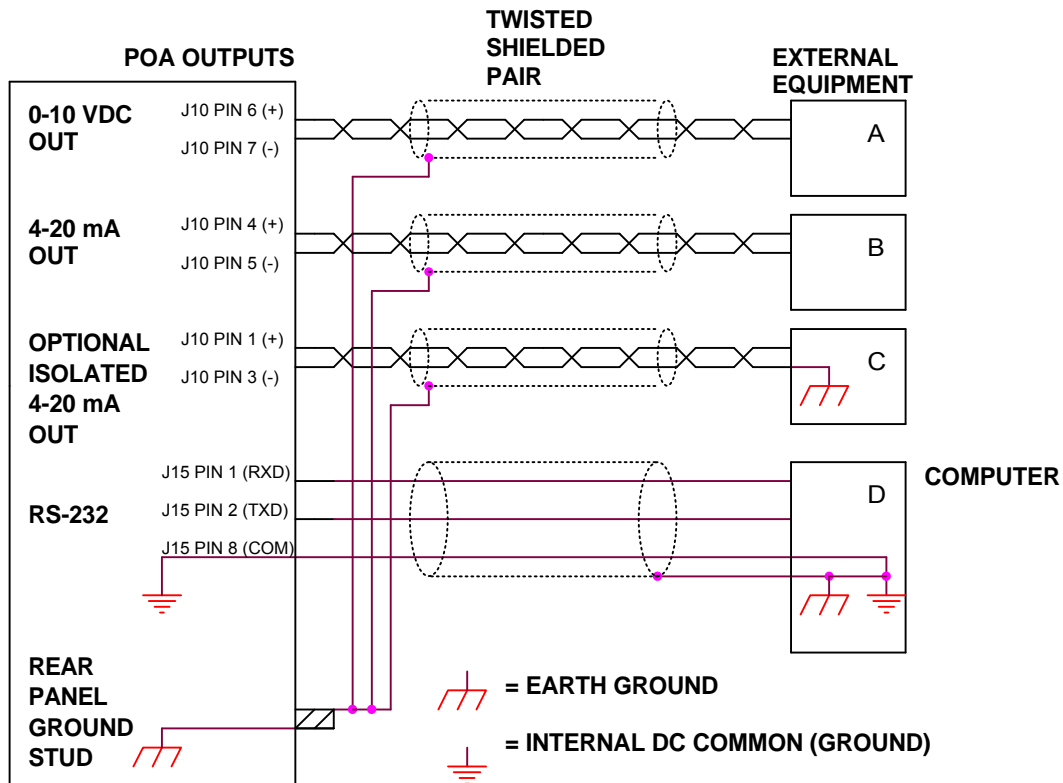
Up to three outputs may be used.

To prevent ground loops, if two pieces of equipment have a signal lead connected to earth ground then one of the pieces of equipment must be connected to the isolated 4-20 mA output.

Connect no more than two pieces of equipment that have a signal lead attached to earth ground.

4.7.3.3 Analyzer With Optional RS-232

**Figure 4-6: Analyzer With Optional RS-232
 And Optional Isolated 4-20 mA, If Equipped**



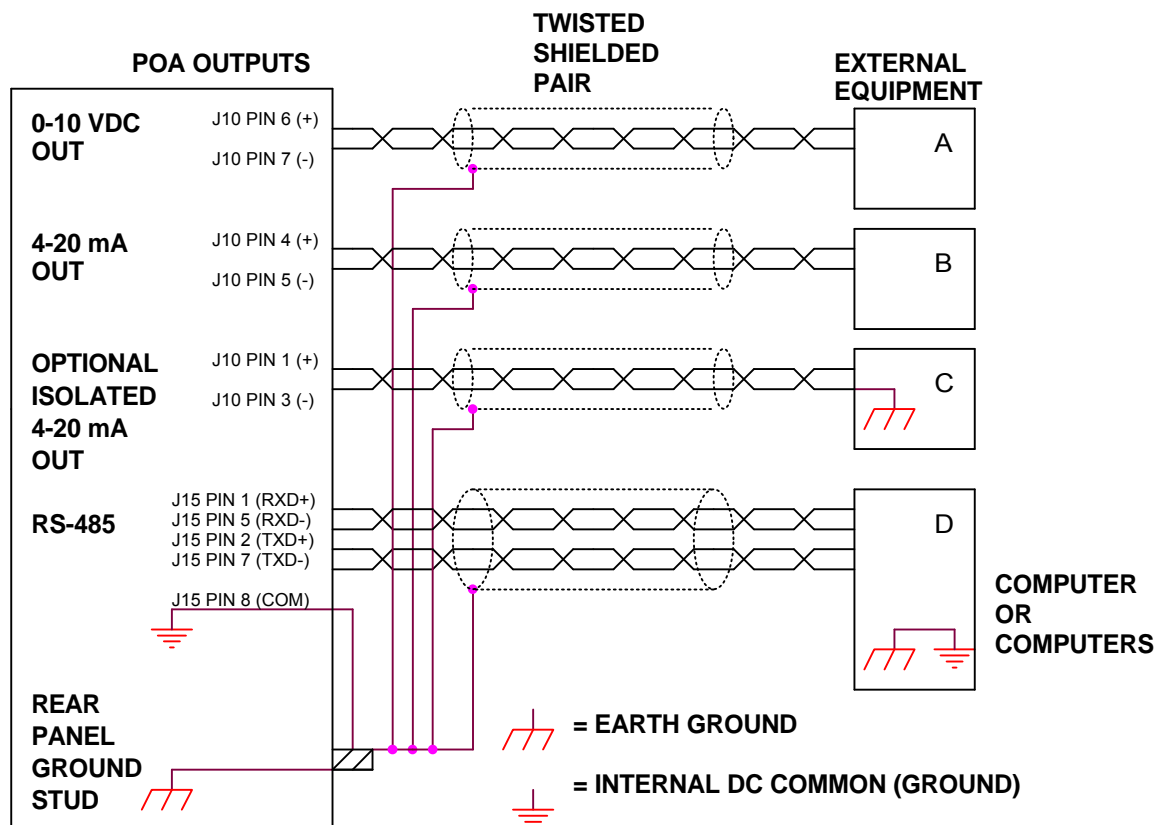
In addition to RS-232 up to three outputs may be used.

The RS-232 signal common is typically connected to earth ground in the computer.

To prevent ground loops, the only piece of additional external equipment that can have a signal lead connected to earth ground is the piece connected to the isolated 4-20 mA output.

4.7.3.4 Analyzer With Optional RS-485

**Figure 4-7: Analyzer With Optional RS-485
 And Optional Isolated 4-20 mA, If Equipped**



In addition to RS-485 up to three outputs may be used.

The RS-485 signal common is typically connected to earth ground in the computer.

To prevent ground loops, the only additional piece of external equipment that can have a signal lead connected to earth ground is the piece connected to the isolated 4-20 mA output.

Note that there must be a customer supplied connection between J15 pin 8 (analyzer DC common) and the rear panel ground stud. This connection references the RS-485 transceivers to earth ground. Although RS-485 is a differential system, it uses earth ground as the third wire connection between the individual pieces of equipment.

5.0 Gas Sample Preparation And Delivery

5.1 Sample Flow Rate And Pressure

The Analyzer is factory calibrated at a 2.0 scfh flow rate, in N₂, and should be operated at that level for optimal accuracy. However, the Delta F Sensor is relatively unaffected by gas sample flow rate, within limits. Sample flow rate should be maintained within the recommended range of 1.0 to 3.0 scfh. The Analyzer can be operated at flow rates outside that range, but it should be recalibrated at that different flow rate to maintain optimal accuracy.

The Analyzer has a small pressure drop (0.2 to 0.5 psi), so relatively small changes in inlet or outlet pressure will cause dramatic changes in flow rate. Consequently, it is preferable to vent the outlet to atmosphere so that outlet pressure will remain constant, leaving inlet pressure as the only variable to control. If the outlet is not vented to atmosphere it is suggested that a pressure gauge be installed on the outlet. Monitoring this gauge will ensure that the pressure differential between the sensor and atmosphere does not exceed the sensor limits of ± 5 psig.

Note: It is not recommended to install a pressure gauge on the inlet side of the Analyzer. Purging time required, and response time in low ppm applications, will increase due to the dead space inside a pressure gauge.

5.1.1 Flow Rate Effects On Sensor Performance

Assuming a perfectly leak-tight system, the higher flow rates may cause O₂ readings to increase by a few percent of reading above the level that would be displayed if flow was within the recommended 1.0 to 3.0 scfh range. Lower flow rates will similarly cause O₂ readings to decrease by a few percent of reading. At very low flow rates (below 0.2 scfh), the incoming sample to the sensor is being scavenged of nearly all O₂, which is continuously being pulled into the sensor cathode by the electrochemical reduction process. This scavenging action makes the O₂ readings much more sensitive to flow rate changes. Therefore, if the Analyzer is recalibrated at a very low flow rate, the flow rate used during normal operation should be held within $\pm 10\%$ of the flow rate used for recalibration.

The Delta F sensor's normal insensitivity to flow rate changes is the basis for the low flow sample system leak detection method described in Section 5.3.4 and 8.2.1. The sensor output should be virtually constant for readings between 0.5 and 4.0 scfh. Therefore, if O₂ readings are higher at the lower flow, then the only explanation is that

ambient O₂ is leaking into the sample system, or venting from a dead space (closed pocket with trapped higher O₂ level gas) in the sample system. In most cases a higher flow rate acts to dilute the atmospheric O₂ leaking into the sample system. And a lower flow rate causes the leaked-in O₂ to have a greater contribution to the actual O₂ level, so readings go up. O₂ readings in a tight sample system should not go up or down significantly with flow changes between 0.5 and 4.0 scfh.

5.1.2 Background Gas Effects On Indicated Flow Rate

If the background gas kinematic viscosity is much different from N₂, then the flowmeter reading may need to be corrected by the use of a compensation factor. This compensation is not to be confused with the Gas Scale Factor, which corrects for background gas effects on the oxygen reading. See Sections 6.4.5.1 and 7.3 for information regarding the Gas Scale Factor.

Primarily, indicated flow compensation is only required when either H₂ or He background gases are sampled. The Analyzer is not particularly sensitive to the flow rate so a considerable flow error will not cause problems as long as the flow remains within the recommended range of 1.0 to 3.0 scfh.

The rotameter type flowmeter used in the Process Oxygen Analyzer is calibrated for use in air (or N₂). Most other gases have kinematic viscosities within $\pm 25\%$ of air. Since the required flow rate is not extremely critical, only those background gases whose kinematic viscosities fall much outside that range are affected.

5.1.2.1 Indicated Flow Corrections For H₂ Or He

Light gases, such as H₂ and He, will have a much higher actual flow rate than that indicated on the flowmeter, which is calibrated for air or N₂. As a result, the flow rate observed on the flowmeter, when sampling either H₂ or He, should be maintained at a level three times smaller than all recommended flow values found in this manual. For example: The recommended flow rate range in N₂ is 1.0 to 3.0 scfh. In H₂ or He service, the recommended flow rate (**as indicated on the Analyzer**) should be 0.3 to 1.0 scfh, with the preferred value being roughly 0.7 scfh. Since the two hash marks on the flowmeter below the 1.0 scfh mark are 0.8 and 0.6 scfh, target the rotameter ball float evenly in between these two marks.

5.1.3 Positive Pressure Operation

If the Analyzer is equipped with a Welded Gas Delivery System With Metal-Face-Seal Inlet connections the sensor inlet flow control valve is absent and may have been replaced with an orifice. See Section 3.11 for special information.

If the sample gas is at constant pressure between 0.2 psig and 10.0 psig, the flow control valve at the sensor inlet can be used to adjust flow rate.

If the pressure in the sample line varies, but does not drop below 2.0 psig, use a regulator to drop the pressure to approximately 1.0 psig. Set final flow rate with the sensor flow control valve.

If a regulator is not used, the flow rate will change when the pressure at the inlet of the flow control valve changes. As long as this pressure variation does not bring the flow rate out of the recommended flow range (1.0 - 3.0 scfh) there is no action required. A flow change of ± 1.0 scfh may result in a small change to the oxygen reading. The change should not exceed $\pm 2\%$ of the reading, which is within the stated accuracy of the Analyzer.

If a pressure change causes the flow rate to move outside the recommended range, an adjustment of the flow control valve must be made. If the adjustment is not made, and the flow rate remains outside the recommended range, the Analyzer may not be operating within its stated accuracy.

CAUTION



Analyzers with a pump are fitted with a valve on the rotameter (downstream of the sensor) and a valve on the sensor inlet (upstream of the sensor). When using a pump to draw a gas sample at less than 0.2 psig, the downstream rotameter valve is used as the flow control valve. The sensor inlet (upstream) valve is shipped from the factory in the fully opened (counter-clockwise) position. Its position should not be changed unless the Analyzer is operated on positive pressure, e.g., when measuring a sample greater than 0.2 psig (but less than the maximum limit of 10 psig) that is vented to atmosphere. Likewise, when operating with a positive pressure the rotameter (downstream) valve should be fully opened and the upstream flow control valve used for flow control. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE THE SENSOR TO EXPERIENCE OVER OR UNDER PRESSURE WHICH MAY CAUSE PERMANENT DAMAGE.

5.1.4 Negative Pressure Operation

If the Analyzer is equipped with a Welded Gas Delivery System With Metal-Face-Seal Inlet connections see Section 3.11.

If a gas sample stream is between -3.0 psig (6.1" Hg vacuum) and 0.2 psig (0.41" Hg vacuum), a pump is recommended. If the Analyzer is equipped with a pump, it will also have a flow control valve in the rotameter (downstream of the sensor) in addition to the sensor inlet (upstream) valve. Section 6.4.5.2 describes calibration when using a pump.

When an Analyzer has a pump, and the Analyzer's outlet is vented to atmosphere, the sensor will operate under negative pressure. By installing a flow control valve between the downstream side of the sensor and the inlet of the pump, that valve can be used to control the pump's vacuum on the sensor. Due to the low pressure drop across the sensor (0.2 - 0.5 psi), only slight pressure changes will occur at the sensor when adjusting the sample flow rate using the downstream flow control valve.

If a pressure change causes the flow rate to move outside the recommended range, an adjustment of the flow rate must be made at the rotameter valve. If the adjustment is not made, the Analyzer may not be operating within its stated accuracy.

CAUTION



Analyzers with a pump are fitted with a valve on the rotameter (downstream of the sensor) and a valve on the sensor inlet (upstream of the sensor). When using a pump to draw a gas sample at less than 0.2 psig, the downstream rotameter valve is used as the flow control valve. The sensor inlet (upstream) valve is shipped from the factory in the fully opened (counter-clockwise) position. Its position should not be changed unless the Analyzer is operated on positive pressure, e.g., when measuring a sample greater than 0.2 psig (but less than the maximum limit of 10 psig) that is vented to atmosphere. Likewise, when operating with a positive pressure the rotameter (downstream) valve should be fully opened and the upstream flow control valve used for flow control. **FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE THE SENSOR TO EXPERIENCE OVER OR UNDER PRESSURE WHICH MAY CAUSE PERMANENT DAMAGE.**

If the normal process sample is being supplied to the Analyzer under moderate vacuum conditions (4" Hg vacuum or higher), such as when taxing the capability of the on-board

pump, the Analyzer should be calibrated with the pump operating even if the calibration gas has sufficient pressure to preclude the use of the pump. The operating pump will create a pressure condition at the sensor that simulates the normal sampling condition.

5.1.5 Pressure Effects On Sensor Performance

If the Analyzer is not vented to atmosphere, the sensor pressure will be influenced by the conditions downstream of the Analyzer. However, in most cases the error introduced is relatively small, and may not affect the process application. If the vent pressure is outside of the range of ± 2 psig, then a recalibration under the user's operating conditions may be desirable to remain within the stated accuracy specifications.

For Analyzers without a pump, Figure 3-1, and that are not vented to atmosphere, the sensor operating pressure may be determined by inserting an in-line pressure gauge at the Analyzer's outlet bulkhead fitting. Add 0.2 to 0.5 psig to the measured pressure to estimate the actual sensor back pressure.

Note: It is not recommended that gauges be installed upstream of the Analyzer. The presence of a gauge will increase purging requirements and response time.

For Analyzers with a pump, an outlet (vent) pressure greater than 4 psig may influence the sensor pressure, causing changes to the flow rate and output.

Sample gas line lengths, fittings and bends should be kept to a minimum to maintain low pressure drops. Larger diameter tubing and fittings will reduce pressure drop and will also lengthen response time. In general, for low pressure applications (less than 5 psig source pressure), 1/8 inch tubing should be limited to 15 foot runs; longer runs should be made with 1/4 inch tubing.

For questions about a specific application, contact the Delta F Corporation Customer Support Services Department at 781-935-5808.

5.2 Gas Sample Compatibility

There are a wide range of considerations in determining the gas sample compatibility of the Oxygen Analyzer. Delta F tries hard to identify all pertinent application details prior to quoting and order processing. All non-typical applications concerning gas sample compatibility are reviewed by our in-house Application Engineers. This is necessary

because it is impossible to accurately predict all of the chemical tolerances under the variety of process gases and process conditions that exist in our many served applications. Our Application Engineers will typically supplement our basic procedures, for predicting gas sample compatibility, with their prior Analyzer field experience. Without access to our broad base of Analyzer experience, it would be difficult even for a customer knowledgeable in chemistry to make an accurate prediction on gas sample compatibility. It is for this reason that we would strongly advise referring to Delta F to make recommendations on gas sample compatibility.

However, the determination of the compatibility of the sensor/analyzer in a specific application is totally dependant upon the accuracy and completeness of application details, such as identifying all relevant gas constituents. It is possible that a process may contain gas constituents as a byproduct of some reaction that is not important to the process, but that could be harmful to the Analyzer. The key is to consider all aspects of the gas sample to identify any potentially harmful effects to the Analyzer that may not have been identified during the original specification of the Analyzer. In an effort to provide basic guidelines for determining gas sample compatibility, the following generic criteria are provided.

5.2.1 Condensation / Liquid Slugs

The Analyzer should be installed and operated with a sample gas that is preconditioned (if necessary) to avoid condensation in the gas lines. Several methods are available to minimize the possibility of condensation. If the sample gas is a hydrocarbon, maintain the gas temperature 20°F to 40°F above its dew point. In some applications, it may be necessary to chill the sample gas before it enters the Analyzer so that the hydrocarbons can be condensed, collected and removed. In those applications it is good practice to pitch the sample gas lines to allow any minor condensation that occurs ahead of the Analyzer to drain away from the Analyzer. Gas sample delivery lines that contain sample gases with high moisture content must not be exposed to temperatures below the dew point.

Careful attention should be paid to the location of the process sample tap to avoid the possibility of having liquid slugs present at the entrance of the sample line. Be certain to also consider process upset and/or normal process maintenance procedures that could be potential sources of liquid slugs. For applications where there is only a remote possibility of a liquid slug, and the duration would be brief, we suggest installing a small coalescing filter (such as the PT-F2S option) in the sample line. For positive pressure applications, the bowl drain port of the coalescing filter can be used as a drain/bypass fast loop connection point. By installing a rotameter with a needle valve at that point, a portion of the total flow can be vented off which will carry away small quantities of condensed liquid and also provide a fast loop to quicken the response time down the

sample line extending from the sample tap to the Analyzer. Contact the Delta F Corporation Customer Support Services Department at 781-935-5808 for specific sample conditioning recommendations.

5.2.2 Gas Solubility In Aqueous KOH Solution

Some gas sample constituents are soluble in the sensor's potassium hydroxide (KOH) electrolyte. Gases which are rated as "Soluble" to "Infinitely-Soluble" may pose a threat to the sensor. If these soluble gases enter the electrolyte and change the wetting properties of the electrolyte, the hydrophobic sensing electrode may become flooded and be rendered non-functional.

Highly water soluble alcohols, for example, should have a limited exposure to the sensor (less than 1% by volume on a continuous basis), and/or be supplemented with periodic electrolyte changes to limit buildup within the electrolyte. Methanol is a good example of a gas which results in this phenomenon. Many gas species with infinite solubility in aqueous KOH, however, that do not affect the electrode or sealing materials, or interfere with the O₂ reduction/oxidation reactions are harmless. Contact Delta F for recommendations on a specific application.

5.2.3 Reactivity With KOH Electrolyte

Many process sample streams contain various concentrations of acid gases. Acid gases are gases which react with the basic KOH electrolyte solution to form a neutralized solution. The standard sensor will not operate properly if the electrolyte solution is neutralized by the presence of any acidic gas species in the background gas. For applications containing modest amounts of acid gases, the STAB-EL sensor can be used. See Section 5.2.6 for details on this topic.

Besides a neutralization of the electrolyte, a base reactive gas sample may have other negative effects, such as a base-catalyzed polymerization reaction. If a solid film should develop, upon contact with the base electrolyte solution, eventually O₂ electrode reaction sites may become blocked by the polymerized byproduct residue at the interface where the gas sample meets the electrolyte.

5.2.4 Sample Gas Flammability

There is nothing within the Analyzer sample system which can ignite a flammable sample gas. However, it is critical to ensure that the sample gas does not escape from the sample system into the Analyzer enclosure, or the room, where ignition is possible.

Stainless steel plumbing should be used throughout the entire sample system if the sample gas is flammable.

Also, the Analyzer enclosure can be purged with nitrogen, or the entire Analyzer mounted in a purged enclosure, so that any sample gas that escapes the plumbing will be diluted.

5.2.5 Abnormal Process Condition Or Maintenance Operation

Process upset conditions or regular process maintenance downtime conditions are often overlooked when considering sample conditioning requirements. These upset or downtime conditions must be considered if the Analyzer is to remain in sampling mode. This is true even if accurate O₂ data are not required during the upset. A solution may be to install automatic solenoid-controlled valves which will switch the Analyzer over to an N₂ purge bypass, or to block-in the sensor with upstream/downstream isolation valves that are actuated when the process reaches some identifiable condition.

CAUTION



Maintenance operations must also be examined for their effect on the Analyzer. For example, in many pipeline process or normal gas applications the system is cleaned with either a liquid solvent or detergent solution. Since either will cause damage to the sensor, the solution is to either shut off sample flow and power to the Analyzer prior to initiating the potentially hazardous process, or by switching the Analyzer over to an N₂ bypass purge.

5.2.6 Capability Of The STAB-EL System

With the STAB-EL system it is possible to make oxygen measurements in sample gases containing varying amounts of acid gases. As a general guide, the data in Table 5-1 represents the maximum allowable limits of acid gases under continuous operation that can be tolerated with the STAB-EL system.

Table 5-1
Maximum Allowable Acid Gas Limits
Using the STAB-EL Sensor

Measuring Range Of Analyzer	CO₂* %	SO₂ ppm	H₂S ppm	NO_x ppm	Cl₂ ppm	HCL ppm
0-50 ppm ["M" Series Sensor]	0.05	50	50	50	25	25
0-100 ppm	0.1	100	100	100	50	50
0-500 ppm	0.1	100	100	100	50	50
0-1000 ppm	0.2	250	250	250	100	100
0-5000 ppm	0.3	500	500	500	200	200
0-10,000 ppm	0.4	750	750	750	400	400
0-5%	1.0	1300	1300	1300	700	700
0-10%	2.0	2000	2000	2000	1000	1000
0-25%	3.0	3000	3000	3000	1500	1500

* Concentrations of CO₂ are in percent. One percent is equivalent to 10,000 ppm.

Contact the Delta F Customer Support Services Department, at 781-935-5808, for recommendations on using the STAB-EL sensor on acid gases other than those listed above.

The STAB-EL limits shown in the table represent rough guidelines for continuous exposure. In most cases, substantially higher acid gas levels can be tolerated on a limited duty cycle basis. For example, a 0-100 ppm sensor can be used to sample a 100% CO₂ background gas for a 15 minute period 3-4 times per week, as long as the balance of the time is spent sampling from a clean gas like N₂, Ar, H₂, etc. In general, a good guideline is to limit the loading on the STAB-EL system to not exceed the continuous limits if the total exposure is averaged over a weekly period. Consult with Delta F for details.

There are applications where the acid gas components may exceed the upper limits of the STAB-EL system on a continuous basis. In such circumstances a sample dilution system can easily be fabricated to mix clean N₂ with the sample gas in a 2:1 to 20:1 ratio using simple pressure control and flowmeter components. Depending upon the continuous acid gas level and the oxygen level to be measured, a dilution ratio must be selected such that the resulting O₂ level is accurately measurable and at least one order of magnitude above the O₂ level in the N₂ dilution gas. Consult the Delta F Customer Support Services Department, at 781-935-5808, for specific recommendations.

Another approach when acid gas levels are continuously above the STAB-EL limits is to enhance the inherent capabilities of the sensor by using a scrubber system. The scrubber will remove the bulk of the acid gases, allowing the Analyzer to provide continuous stable measurements. If a breakthrough occurs, the sensor's ability to tolerate high levels of acid gas for limited periods of time will avoid catastrophic loss of performance.

Delta F offers a broad range of scrubbers for applications in severe environments. Standard scrubber columns are available in various sizes, and in single or dual bed configurations. The columns are fabricated from clear PVC and are designed to accept a variety of different acid gas absorbent media which have a color-change indication to facilitate convenient change-out. For more information, contact the Delta F Customer Support Services Department at 781-935-5808.

5.3 Normal Installation And Operation Considerations

Consistent, high performance from the Process Oxygen Analyzer requires an understanding of the gas delivery system and proper installation methods and techniques.

This section describes many issues that the user should be aware of during the installation, operation and calibration of the Analyzer.

5.3.1 Normal Operating Conditions

All Delta F Analyzers are factory calibrated and thoroughly checked to assure compliance with advertised performance claims under **Normal Operating Conditions**. In addition, all recommended maintenance programs assume that the Analyzer is being operated under these conditions (see Section 8.1 for more details). The normal operating conditions for all range Platinum Series Process Oxygen Analyzers are as follows:

Table 5-2
Normal Operating Conditions

Physical Parameter	Recommended Range	Normal Operating Range
Sample Pressure (See Note 1)	atmospheric + (0.2 to 0.5 psig)	-2 psig to 2 psig
Sample Flow	2 scfh (1 slpm)	1-3 scfh (0.5 - 1.5 slpm)
Sample Temperature (See Note 2)	75°F ± 10°F (25°C ± 5°C)	40°F - 113°F (5°C - 45°C)
Ambient Temperature	75°F ± 10°F (25°C ± 5°C)	45°F - 95°F (7°C - 35°C)

Note 1: Pressure as would be measured specifically at the sensor. See Section 5.1.5 on how to either measure this pressure or estimate it.

Note 2: Sample temperature mentioned here refers to the temperature of the sample as it arrives at the sensor inlet. Since gas samples typically cool or heat readily to the temperature of the sample lines (see Section 5.3.2), the gas temperature can be changed, to meet the normal operating range limits, by simply allowing 6 or more feet of sample tubing ahead of the analyzer to come to ambient temperatures.

If operating outside of the normal operating conditions contact Delta F for the anticipated effects on Analyzer performance and maintenance requirements.

5.3.2 Sample Gas Temperature Control

Gas temperature should not exceed 113°F (45°C), nor should it fall below 40°F (5°C). Gas temperature can be controlled by passing the gas through 5 to 10 feet of metal tubing that is within the recommended sample temperature range. Because of its low thermal mass, the gas sample will quickly reach the gas sample line temperature.

5.3.3 Back Pressure/Sample Outlet Vent

It is always recommended to vent the Analyzer to atmospheric pressure. However, if a sample vent or return line must be used, proper attention must be given to maintain a low and consistent back pressure so as not to catastrophically affect the flow rate.

The maximum/minimum continuous allowable back pressure on the sensor is ± 5 psig. On Analyzers equipped with a rotameter, with an integral valve, that valve is located downstream of the sensor, and so could be used to throttle a vacuum vent line to draw sample through the Analyzer. If variations in the vent line pressure are expected, a sub-atmospheric back pressure regulator should be installed to maintain an even back pressure on the Analyzer. Ensure accounting for the regulator's pressure drop (typically 1 psi) when designing the sample vent system, in order to stay within the ± 5 psig pressure limits at the sensor.

When not venting the Analyzer to atmosphere, it is suggested to install a fairly high resolution pressure gauge immediately at the Analyzer outlet.

5.3.4 Checking For Plumbing Leaks

Significant measurement error can be caused by leaks in the plumbing system. A simple test can be performed to identify oxygen leaks into the sample gas stream:

Observe the readout at two flow levels: 0.5 and 3.0 scfh. Only a slight increase, if any, in oxygen readout is expected in a tight system as the flow is increased. If leakage in the plumbing system exists, then the increased flow will result in a substantial decrease in oxygen readout -- typically dropping in level by as much as 25 to 50%.

When flow sensitivity is observed, check the external plumbing for leaks. If the gas delivery lines are tight, remove the sensor assembly from the enclosure (refer to Section 2.2) to check the internal connections. Carefully check the stem and packing on the sensor inlet flow control valve. The valve stem packing should be tight to minimize leaks.

If a leak is suspected in the gas inlet line, fully close the sensor inlet flow control valve (clockwise). Pressurize the inlet gas line to 5 to 10 psig. Use a soapy solution (like Snoop[®]) to identify leaks. After performing the leak test, carefully open the sensor inlet flow control valve to allow the pressurized sample gas line to slowly bleed down to the operating pressure.

Refer to Section 8.2.1 for further information regarding the diagnosis of plumbing leaks.

5.4 Sampling Considerations During Calibration

Calibrations performed from a bottled calibrated sample gas introduce additional issues that could adversely affect calibration accuracy. Generally, low trace range instruments require more fastidious techniques during the calibration procedure.

5.4.1 Calibration Standards

Certified calibration standards are available from gas manufacturers. These standards are available in steel and aluminum cylinders. Steel cylinders are less expensive but will not dependably maintain a stable oxygen concentration for long periods of time. However, if the calibration gas utilization rate is high, steel may be suitable. At the factory, calibration gases in steel cylinders are recalibrated every three months.

For low range Analyzers, (100 ppm or less), calibration standards in aluminum cylinders are recommended. Delta F has found that calibration standards in aluminum cylinders are very stable for long periods of time (6 to 24 months).

5.4.2 Cylinder Regulators

Regulators used on bottled calibration standards will typically be equipped with two Bourdon pressure gauges, one to measure the cylinder pressure, and the other to measure the outlet pressure. The regulator must have a metal (preferably stainless steel) diaphragm. Install a flow control valve after the regulator to adjust the flow.

CAUTION



Erroneous calibration check results will occur if the regulator being attached to the span gas cylinder is not very thoroughly purged before use.

Before the calibration gas is connected to the Analyzer follow the procedure listed below to satisfactorily purge ambient air from the regulator:

- a. After securely attaching the regulator to the cylinder, fully adjust the regulator (clockwise) to its maximum outlet pressure capability. Slightly open the regulator flow control valve. Open the cylinder valve.
- b. Adjust the flow control valve to allow a modest flow rate (hissing sound).
- c. Close the cylinder valve until the cylinder pressure falls to nearly 0.0 psig on the secondary pressure gauge, or until flow almost stops.
- d. Immediately open the cylinder valve to restore full delivery pressure.

- e. Close the cylinder valve to again drop the outlet pressure and flow to near zero.
- f. Repeat steps c. and d. at least 20 times to thoroughly purge the regulator and gauges. This pressure cycling action (as witnessed by the high and low pressure gauges going from high pressure to near zero) acts to flush out all the air trapped in the dead space and cavities inside the regulator.
- g. Adjust the regulator to set the delivery pressure at about 5 - 10 psig.
- h. Close the flow control valve.

The above procedure insures that any ambient air trapped in the pressure gauges and cavities of the regulator will be purged prior to performing a gas calibration.

Once the regulator is mounted, do not remove it from the cylinder until a fresh cylinder is required. This protects the cylinder from the introduction of any O₂ contamination which may be introduced into the bottle from a regulator containing trapped air.

Note: Once the regulator has been purged and then connected to the Analyzer using appropriate metal sample lines with no dead legs and good quality fittings, the Analyzer can be used to determine if further purging is required. With the Analyzer sampling from the cylinder at the normal flow rate, shut off the main cylinder valve and allow the sample line pressure to bleed down through the Analyzer. When the flow drops below 0.5 scfh, open the valve to restart sample flow.

The O₂ readings should stay relatively stable while the regulator is bleeding down (assuming that readings were relatively stable prior to starting this process). If O₂ readings shoot up (i.e., by 20% of reading or more) while the pressure is dropping, or just after re-opening the cylinder valve, this indicates that further regulator purging is required or that there is a leak in the regulator assembly or lines leading to the Analyzer. Also see Section 8.2.1 for more information about leak checking.

5.4.3 Process Conditions During Calibration

5.4.3.1 Delivery And Vent Pressure During Calibration

This section applies to process installations where the sample is being delivered to the Analyzer under vacuum conditions, or being returned from the sample outlet under either positive pressure or vacuum conditions. Under these circumstances, the operating pressure at the sensor itself is likely to be quite different than under factory calibration conditions.

The most accurate calibration is obtained when the Analyzer is plumbed into the gas sample system so that the Analyzer is under actual process operating conditions. For systems where the gas sample is not vented to atmosphere, the Analyzer outlet should remain connected to this same vent during calibration, if possible. This will ensure that downstream pressure effects on the sensor are the same during calibration and process monitoring.

Use the flow control valve on the regulator to meter the calibration gas to the Analyzer at the suggested 2.0 scfh flow. By leaving the Analyzer's flow controls untouched from when the Analyzer is used on process, the calibration pressure will duplicate the process sampling pressure.

5.4.3.2 Background Gas Effects On Calibration

Ideally, the calibration gas and the process gas will have the same gas composition, and the indicated flow rate during calibration and process sampling will be identical. However, if the calibration and sample gases are not the same composition the flow rate indicated on the rotameter may need to be compensated because the flowmeter is calibrated on air (or N_2). Light gases, such as H_2 and He, will have a much higher actual flow rate than that indicated on the flowmeter. As a result, the flow rate observed on the flowmeter, when sampling either H_2 or He, should be maintained at levels three times smaller than all the specifications for flow found in this manual. For example: The recommended flow rate range in N_2 is 1.0 to 3.0 scfh. In H_2 or He service, the recommended flow rate (***as indicated on the Analyzer***) should be 0.3 to 1.0 scfh, with the preferred value being roughly 0.7 scfh. Since the two hash marks on the flowmeter below the 1.0 scfh mark are 0.8 and 0.6 scfh, target the rotameter ball float evenly in between these two marks.

During calibration a gas scale factor may have to be applied to oxygen readings because of the difference between the diffusion rate of oxygen in nitrogen (factory calibration gas) versus the diffusion rate in the user's calibration gas. Section 6.4.5.1

discusses the proper setting of the gas scale factor option during calibration. Section 6.4.5.2 discusses the actual calibration procedure.

CAUTION



The GSF for the gas used to calibrate the system may be different from that used during analysis. If the GSF is changed to reflect the composition of the calibrating gas, be sure to reset the GSF before analyzing samples.

Disclaimer

The method used to correct the calibration of the Delta F Oxygen Analyzer for measurement in non-nitrogen background gases is derived from a well known theoretical mass transfer equation. This equation accounts for the change in oxygen diffusion rates through different gases.

Although significant empirical work has been done in this field, it is generally accepted that the equation may be only 85-90% accurate. In addition, there is further error introduced when correcting for a "multi" component background gas. This may result in an additional 3-5% error. Correcting the calibration (for all combinations of background gases) using theoretical means has its limitations.

An alternate method when using a non-nitrogen or "multi" component background gas is to obtain a certified oxygen calibration standard which has been prepared in a background gas which models the average process sample. In this case any possible error introduced in using the theoretically derived correction factor is eliminated. Caution must still be used, however, as certified standards may also have inaccuracies associated with them.

Questions regarding the calculation of a background gas correction factor for a specific application should be directed to the Delta F Customer Support Services Department at 781-935-5808.

In light gas (H_2 or He) backgrounds, the diffusion rate of oxygen will be greater than that in nitrogen, resulting in a higher absolute current generated by the sensor. If the sample contains an oxygen concentration near the high-end of the instrument (e.g. 80 ppm on a 0-100 ppm unit), and consists of a light gas background, the current generated by the sensor may be too much for the electronics to source and will effectively put the instrument out of range. In such a case, it would be appropriate to use an analyzer of the next highest range (e.g. 0-500 ppm). Consult Delta F for application specific details.

6.0 User Interface

6.1 Introduction

When the Platinum Series Process Oxygen Analyzer is powered up, it goes through a series of internal diagnostic tests which take about five seconds. After the tests, the Delta F logo appears for ten seconds. The display will then show the Data Display Screen seen in Figure 6-1.

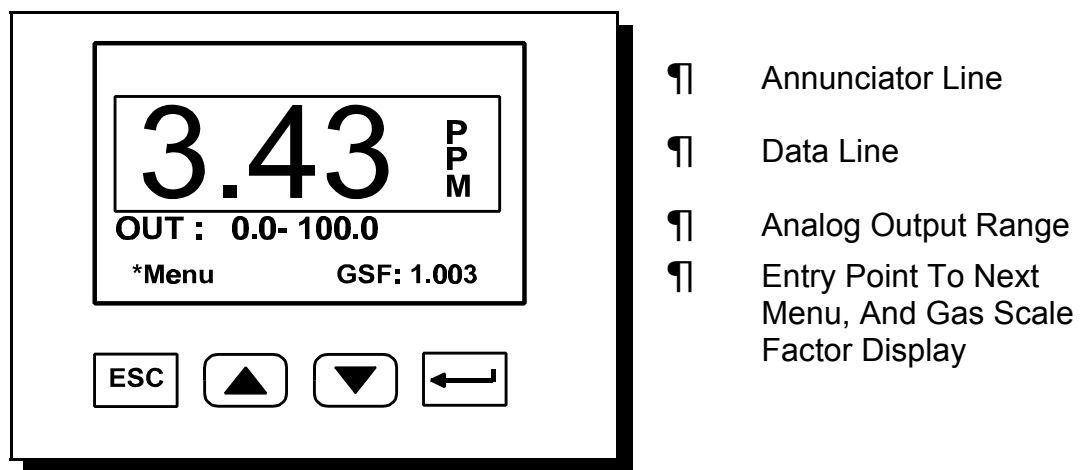


Figure 6-1. Data Display Screen

The numerical information shown in Figure 6-1 is representative. Different values will probably be observed on the display.

There are four pressure sensitive keys below the display, shown in the lower part of Figure 6-1. The keys are used as follows:

- ESC - Returns the display to the previous screen, or may be used to move to the left when within a data field selection.
- - Scrolls up in a menu or data selection.
- - Scrolls down in a menu or data selection.
- ¶ - Accepts the selected (asterisk) entry, allows data field selection, and may be used to move to the right when within a data field selection.

The **Annunciator Line** provides information about the status of the Analyzer, and alarm conditions. The Annunciator Line is displayed on the Main Menu Screen (Figure 6-2).

The **Data Line** indicates the measured oxygen concentration (e.g., 3.43 ppm). In this manual all concentrations will be shown in ppm O₂. For instruments that display data in percent O₂ all actions are identical, but engineering units will be reported in percent.

Below the Data Line is a display of the **Analog Output Range** settings. The analog outputs are scaled over the range displayed in this area. Factory standard analog outputs are 0-10 VDC (see Section 4.5) and 4-20 mA (non-isolated). Setting the output is described in Section 6.4.2. If the Analyzer is equipped with the Expanded Range Scale option the Analog Output Range value will change from OUT: x-xxxx to XPOUT: x-xxxx, and will appear in reverse video, when the expanded range scale is active.

* **Menu** indicates that if  is pressed, the Main Menu display (Figure 6-2) will appear.

GSF indicates the present Gas Scale Factor. The Gas Scale Factor is described in Section 6.4.5.1. If the Analyzer is not equipped with the GSF option, or if N₂ is selected from the GSF table, then no GSF is displayed.

The legend "OVER RANGE" will overwrite the Oxygen display if the instrument analog to digital converter reads a value which is over or under its full scale range. During an over range condition the oxygen information is not valid. The analog output will be at maximum (pegged). An "OVER RANGE" condition will result in a continuous alarm tone, which may be silenced by pressing ESC.

The legend "SENSOR OFF !" will overwrite the Oxygen display if the sensor polarization voltage is turned off by using the Sensor selection in the Controls menu. The polarization voltage will automatically turn off if the Analyzer is OVER RANGE for more than 30 minutes. When the sensor is off the analog output falls to zero volts and the 4-20 mA output falls to 4 mA. An optional relay may be configured to indicate that the sensor is off. A "SENSOR OFF !" condition will result in an intermittent alarm tone, which may be silenced by pressing ESC.

A reverse video overlay will appear over the center of the display for the following alarms: Oxygen (1,2,3,4), Temperature (T), Flow (F), and Electrolyte Condition (E). The overlay appears and disappears at intervals so that the Oxygen reading is still visible. If there are several alarms in progress all of the alarm overlays will be displayed in sequence.

The overlay also indicates the set point value and whether the alarm condition is a high or low alarm. If the alarm is a Flow Or Electrolyte Condition alarm the set point is not displayed because these alarms do not have set point values. Audible annunciation

can be activated for each of the alarms. If annunciation is activated, a continuous tone will occur when the overlay is displayed. Pressing ESC while the overlay is displayed will silence the tone and cause the overlay to disappear. Once an alarm has been acknowledged (by pressing ESC) its number will be continuously displayed in the Data Display Window on the Annunciator Line. The numbers are assigned as follows:

Alarm Number	Function
1	Oxygen 1
2	Oxygen 2
3	Oxygen 3
4	Oxygen 4
T	Temperature
F	Flow
E	Electrolyte Condition

The alarm number will clear only after the alarm condition is over.

For simultaneous alarms, each will alternately overwrite the display. Successive presses of ESC (as the overwrite is displayed) are necessary to clear the overwrite and annunciation. This will not clear the alarm. Only a restoration of the condition that existed prior to the alarm will clear the alarm.

There are also a number of special messages that can appear on the Annunciator Line of the display:

BAT LOW	-	Indicates that the backup battery should be recharged (occurs only if the battery option is installed on this unit).
TEMP OVER RANGE	-	Indicates that the sensor temperature is over 50°C or that the temperature probe is disconnected. This alarm results in a continuous tone that may be silenced by pressing ESC.
UNDER RANGE	-	Indicates that the oxygen level is below the calibrated zero.
UNCALIBRATED	-	Warns that the Analyzer is not calibrated, or that NOVRAM data has been corrupted.

If there is an acknowledged alarm indicated in the Annunciator Line, special messages will appear in the upper left corner of the oxygen display box. A Low Battery condition will display as **BT**, Temp Over Range will show **TO**, and Under Range will show **UR**.

Other possible messages, that may appear on various screens, include “Wait!”, and “Memory Error!” “Wait!” indicates that the instrument is performing an operation that is time consuming (> 10 seconds), such as an internal electrical zero calibration. “Memory Error!” indicates that the instrument has failed the boot-up memory test. Perform a Memory Test using the Diagnostics Menu and if it fails contact the Delta F Customer Support Services Department at 781-935-5808.

6.2 The Main Menu

The Main Menu, Figure 6-2, is accessed by pressing **↵** from Figure 6-1, the Data Display Window. Alarm Overlay information will display over the Main Menu.

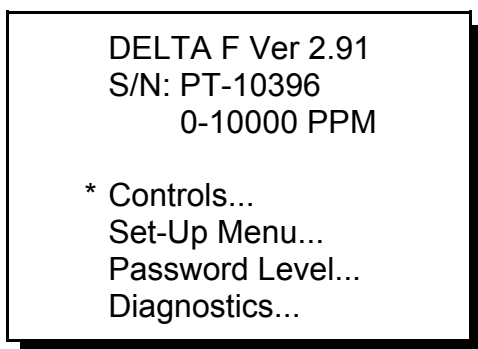


Figure 6-2: Main Menu

The first three lines of the Main Menu display the firmware version, followed by the instrument serial number and the range of the Analyzer.

Four screens can be accessed from the main screen:

- | | | |
|-------------|---|---|
| Controls | - | Used to turn on the Quick Start feature, pump, heater, or sensor voltage, choose sensor off relay, and select power up default conditions for the above functions (Section 6.3). |
| Set-Up Menu | - | Used to set alarm parameters, the recorder output level and functions, configure communication port, to enter the gas scale factor, to perform or check the span calibration, or to install a replacement sensor (Section 6.4). |

- | | | |
|-------------|---|---|
| Password | - | Used to set passwords and indicate which menus are "password" protected (Section 6.5). |
| Diagnostics | - | To test a variety of functions of the system such as analog outputs, alarm relays, memory and screen, to display the sensor core temperature, and to calibrate the sensor zero (Section 6.6). |

The diagram in Figure 6-3 shows the "Menu Tree" for the operator interface. Sufficient detail is provided to orient the user during instrument set-up; however, not all the program details are illustrated in this diagram.

Each level in the Main Menu allows the user to access options for setting and testing instrument parameters. **Ellipsis (...)** after an entry indicate that additional screens follow.

6.2.1 Programming Protocol

The following protocols are used to program the Analyzer:

To access a level, use the • or — key to move the asterisk (*) to the desired level and press **↵**.

To edit a numerical value, use the **↵** key to highlight (reverse video) the digit to be changed. Successive use of the **↵** key will highlight the digits on a left to right basis. Use of the ESC key will move the highlighting back to the left and eventually cancel any adjustment. The rightmost digit will be the active digit for editing. Use • or — to adjust the desired value.

After the desired numerical value has been entered, press the **↵** key until the number no longer appears in reverse video.

The ESC key is used to return to the previous screen without changing any parameters that may have been altered. If any parameters have been edited without updating memory, the display will present the message "**ABANDON CHANGES?, ↵ FOR YES**". All parameter changes will be **lost** if the **↵** key is pressed.

Select the UPDATE & QUIT choice using **↵** to save the changes and automatically return to the previous menu.

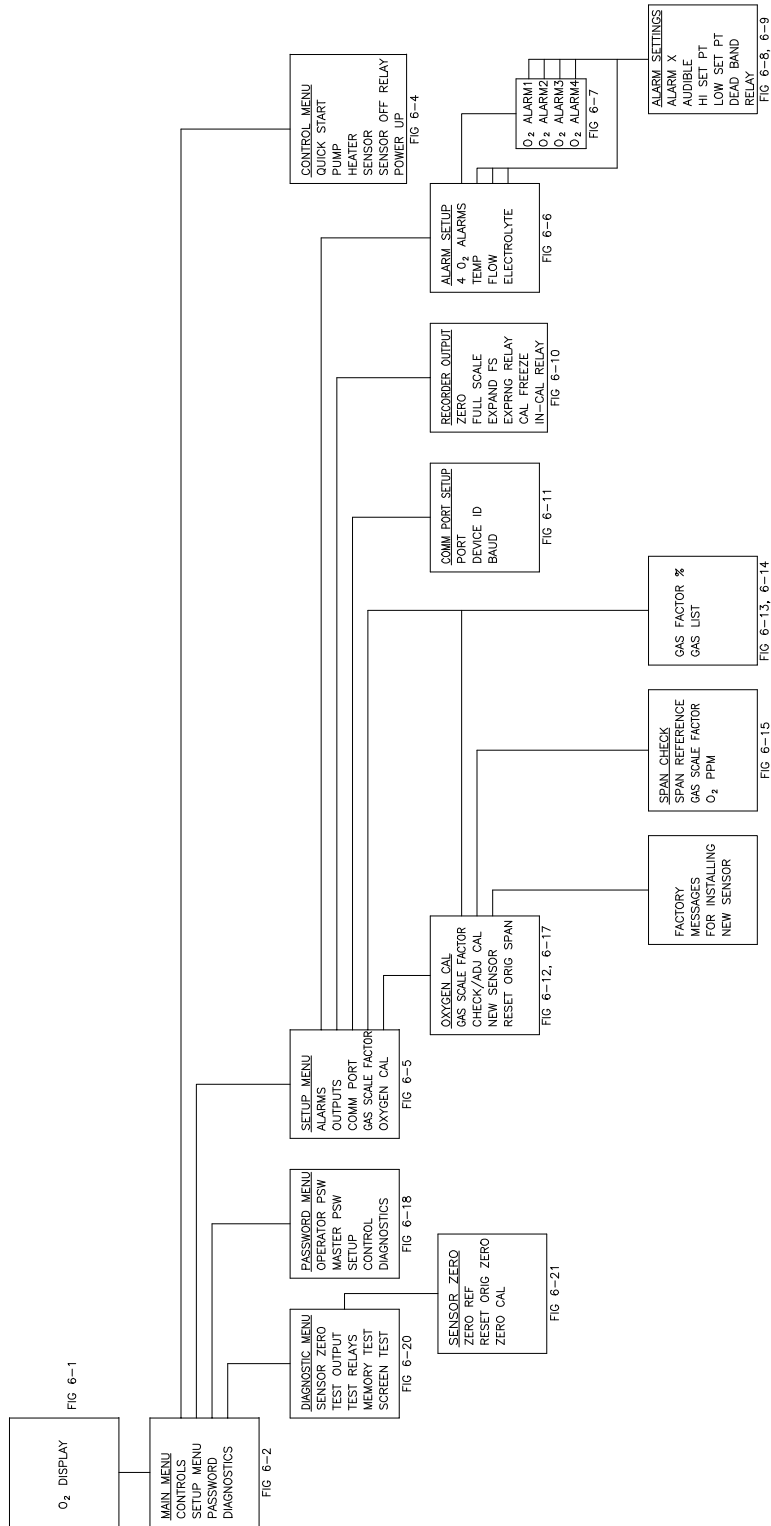


FIGURE 6-3 MENU TREE -- OPERATOR INTERFACE

6.3 Controls

The Controls menu is used to turn on or off a number of optional features of the Oxygen Analyzer. When the Controls menu is selected, and the appropriate password is entered (if required), the display will show Figure 6-4.

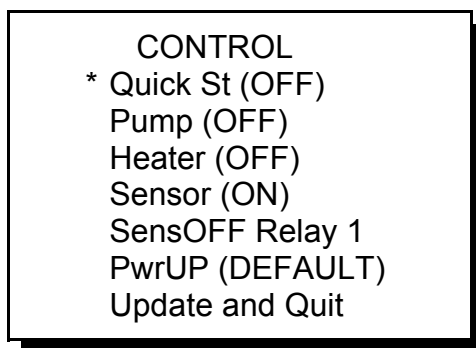


Figure 6-4: Control Menu

6.3.1 Quick St(art)

(Optional) - Selecting the Quick Start entry initiates the feature. If the Analyzer does not have quick start, **NA** will be displayed. If the sensor is turned off the Quick Start function will not operate.

The Quick Start command is used to bring the Analyzer on-line quickly or re-equilibrate faster to low ppm values following a higher ppm excursion. Quick Start can be used when the Analyzer is first turned on to decrease the time to reach equilibrium, especially when the gas sample is less than 10% of the Analyzer's range, or below 100 ppm.

During the operation of Quick Start, the display will count down the remaining time from approximately 40 seconds. At the end of the quick start period, the display will return to the main oxygen display shown in Figure 6-1. Anytime during the 40 second countdown, Quick Start can be canceled by pressing ESC twice.

CAUTION



To prolong sensor life, it is recommended that Quick Start not be used more than six times in a 24 hour period.

6.3.2 Pump

(Optional) - After accessing the Pump entry, the pump is toggled ON or OFF by pressing **↵**. If the Analyzer does not have a pump, **NA** will be displayed. See Section 6.3.7, ESC, for information about leaving the menu after changing the Pump setting, and Section 5.1.4 for details about operating with negative pressure.

CAUTION



Analyzers with pumps are fitted with a valve on the rotameter (downstream of the sensor) and a valve on the sensor inlet (upstream of the sensor). When using a pump to draw a gas sample at less than 0.2 psig, the downstream rotameter valve is used as the flow control valve. The sensor inlet (upstream) valve is shipped from the factory in the fully opened (counter-clockwise) position. Its position should not be changed unless the Analyzer is operated on positive pressure, e.g., when measuring a sample greater than 0.2 psig (but less than the maximum limit of 10 psig) that is vented to atmosphere. Likewise, when operating with a positive pressure the rotameter (downstream) valve should be fully opened and the upstream flow control valve used for flow control. **FAILURE TO FOLLOW THESE INSTRUCTIONS MAY CAUSE THE SENSOR TO EXPERIENCE OVER OR UNDER PRESSURE WHICH MAY CAUSE PERMANENT DAMAGE.**

6.3.3 Heater

(Optional) - After accessing the Heater entry, the heater is toggled ON or OFF by pressing **↵**. If the Analyzer does not have a heater, **NA** will be displayed. If the sensor temperature exceeds 45°C the heater will be automatically shut off to protect the sensor. See Section 6.3.7, ESC, for information about leaving the menu after changing the Heater setting.

6.3.4 Sensor Polarization

After accessing the Sensor entry, the sensor power is toggled ON or OFF by pressing **↵**. The sensor ON command applies a polarizing voltage to the sensor. See Section 6.3.7, ESC, for information about leaving the menu after changing the Sensor setting.

The Analyzer has been programmed to protect the sensor from extended operation in an over-range condition (> 30 minutes). If such a condition exists, the software will turn off the polarizing voltage to the sensor. A message will be displayed (see below) indicating that the sensor has been turned off, and an intermittent beep will occur. The beep can be silenced and message canceled by pressing ESC. When ESC is pressed a reverse video SENSOR OFF! legend will overlay the oxygen display.

The user should investigate the reason for the excessively high O₂ level, remedy the situation, and then restore power to the sensor via the Controls menu. The oxygen value is approximately zero when the sensor is off. Also, the analog outputs will go to zero, so any low Oxygen alarms set above zero will trigger on.

SENSOR SHUT OFF
LOWER O2 LEVEL

USE CONTROL MENU
TO RESTORE
POLARIZATION

6.3.5 SensOFF Relay

When the sensor is manually turned off from the front panel, or automatically turned off because the instrument has been over-range for more than 30 minutes, a relay may be assigned to signal that the sensor is off. This feature is important when the Analyzer is used in an unattended area, so that a remote operator can be notified that the instrument is no longer measuring oxygen. If the instrument is not equipped with any relays this selection will show **NA**. It is possible to assign more than one alarm or status condition to any relay. Since the status condition of the sensor, being switched off, signifies an “Analyzer Off-line” condition, it is important to make sure that the relay assigned to SensOFF service is only assigned to alarm conditions signifying similar levels of alert, such as a Low Flow Alarm.

Note: Alarm or Analyzer status conditions that signal an “Analyzer off-line” fault condition (such as sensor off) can be assigned to a single relay contact used as a trouble indicator. If the Analyzer signal is only monitored remotely, it is suggested to route the 4-20 mADC signal through the “Analyzer Trouble” relay such that an alarm condition will cause the relay to break the current loop. This method allows a computerized system to be configured to detect an analyzer fault condition whenever the 4-20 mADC signal is below 4 mA.

6.3.6 P(o)w(e)r UP

When the Analyzer is powered down, and then turned back on, the pump and heater controls default to OFF, and the Sensor defaults to ON. This activity is the DEFAULT operational mode of the pump, heater and sensor. Instead, it is possible to store the states of the pump, heater, and sensor every time they change and allow the LAST state to be reestablished when the Analyzer is powered up. The selection “PwrUP” toggles between “DEFAULT” and “LAST”.

6.3.7 ESC

If only the Pump, Heater, or Sensor selection has been changed, and the PwrUP selection is set to DEFAULT, the Controls menu may be exited with ESC. The new changes will be in effect. If SensOFF Relay or PwrUP has been changed, and the changes are to be stored, or the PwrUP selection is set to LAST, the menu should be exited by selecting Update and Quit. If the changes are to be discarded press ESC. The Analyzer will present the message “**ABANDON CHANGES?, ¶ FOR YES.**” Press enter and the display will return to the Data Display Screen shown in Figure 6-1.

6.4 Set-Up

Note: When the Set-up entry is selected from the Main Menu, a DISABLING ALARMS message appears which notifies the user that the alarms have been temporarily disabled. The alarm overlay messages will not show in the display. **Relays will remain in the alarm state that immediately preceded the Disabling Alarms message.**

The Set-Up Menu is used to establish a variety of Analyzer parameters. When the selection is made and the appropriate password is entered (if required), Figure 6-5 is shown.

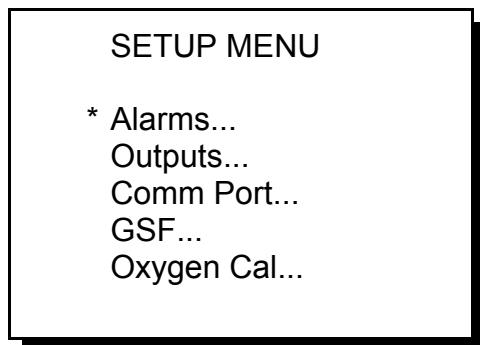


Figure 6-5: Set-Up Menu

Each entry in Figure 6-5 leads to a sub-menu as shown in Figure 6-3. To select the desired sub-menu, use • or — to place the asterisk next to it, then press \uparrow . A new display will be shown as indicated below.

6.4.1 Alarms

The Alarms screen is used to set or determine the status of alarms. When the Alarms entry is selected from Figure 6-5, the display will present Figure 6-6.

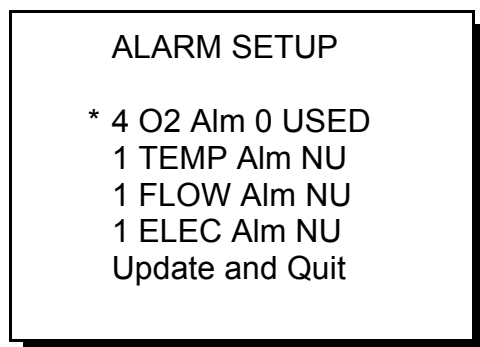


Figure 6-6: Alarm Selection Menu

To select an alarm to edit, use the • and — keys to move the asterisk. Press \uparrow when the alarm is indicated. If (NA) is displayed next to any entry, that alarm option is Not Available.

6.4.1.1 O₂ Alarms

If an O₂ alarm has been selected, the display will show Figure 6-7.

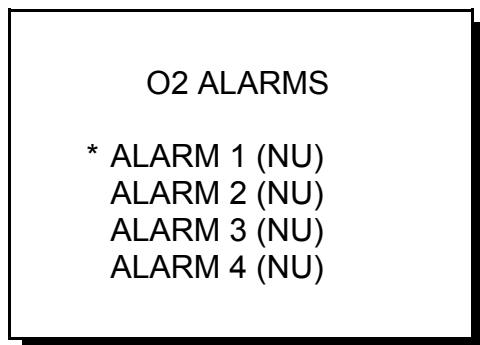


Figure 6-7: Oxygen Alarm Selection Menu

After selecting an Alarm, use \uparrow to toggle the alarm On (USED) or Off (NU). When an unused alarm (NU) is accessed, the display will appear as shown in Figure 6-8. (Oxygen ALARM 1 is used in the example shown in Figure 6-9.)

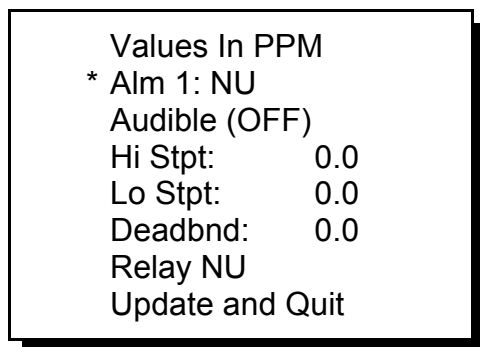


Figure 6-8: Alarm Set-Up Screen (Alarm Not Used)

To indicate that the alarm is to be used, move the asterisk to Alm 1: and press \uparrow . For the oxygen alarms, the **NU** will change to **O2**.

Audible is used to toggle On or Off the audible alarm feature. The **Hi Stpt** (high set point) and **Lo Stpt** (low set point) refer to the limits above and below which the alarm will be triggered.

Each oxygen alarm (and the temperature alarm) can be set for a high trip point and a low trip point. This feature gives the user the ability to operate the process between limits of high and low O₂ concentration (or temperature range) using only one alarm.

Deadband refers to how far the current value must be above (for lo alarms) or below (for hi alarms) the set point before an alarm is reset. For example, for a High Alarm (Hi Stpt) set to 50 ppm, a Low Alarm (Lo Stpt) set to 30 ppm, and the deadband (Deadbnd) set at 5 ppm, the alarm will trigger at 50 ppm. The alarm will continue to report until the oxygen concentration falls below 45 ppm (Set point minus Deadband). At 45 ppm, the alarm will reset.

With the Low Alarm, the alarm would trigger at 30 ppm and continue to report until the O₂ concentration increased to 35 ppm (Set point plus Deadband). At 35 ppm the alarm would reset.

Relay indicates the relay to which the alarm is assigned. The options are NU (not used), 1, 2, 3 or 4. Each relay can be assigned up to seven alarms. If more than one alarm is assigned to a relay, any assigned alarm will trip the relay, and the relay will remain tripped until ALL alarms assigned to it are cleared. The alarm can be assigned to only one relay.

If an active alarm is accessed, the display will indicate the present values. An example of an active alarm (O2 Alm 1) is shown in Figure 6-9.

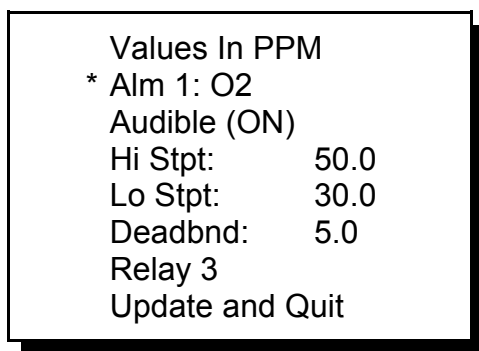


Figure 6-9: Alarm Set-Up Screen
(Alarm Used)

6.4.1.2 Temperature Alarm

The **TEMP** alarm is used to indicate an out of range temperature condition for the sensor. From Figure 6-6, selecting TEMP Alm (ON) will bring a display similar to Figure 6-8. The alarm can be assigned to any one relay.

The temperature alarm is programmed in the same way as an O₂ alarm. The temperature alarm cannot be set to a value greater than 45°C. It is recommended that the High Set point be set at 40°C.

6.4.1.3 Low Flow Alarm

The **FLOW** alarm is used to indicate a low flow condition. The optional low flow switch will trip if the flow rate drops below the value listed in Table 6-1.

Table 6-1
Approximate Trip Point For Flow Switch

Gas	Trip Point (scfh)
Air	0.25
Ammonia	0.33
Argon	0.22
Butane	0.18
Carbon Monoxide	0.26
Ethane	0.25
Ethylene	0.26
Helium	0.69
Hexane	0.15
Hydrogen	0.96
Methane	0.34
Nitrogen	0.26
Propylene	0.21

From Figure 6-6, selecting FLOW Alm (ON) will bring a display similar to Figure 6-8. The alarm can be assigned to any one relay.

The flow alarm is programmed in the same way as an O₂ alarm. However, the values for Hi Stpt, Lo Stpt and Deadbnd will indicate **NA**. These values cannot be accessed.

6.4.1.4 Electrolyte Condition Alarm

The **ELEC** alarm is used to indicate electrolyte condition. From Figure 6-6, selecting the ELEC Alm (ON) will bring a display similar to Figure 6-8. The alarm can be assigned to any one relay.

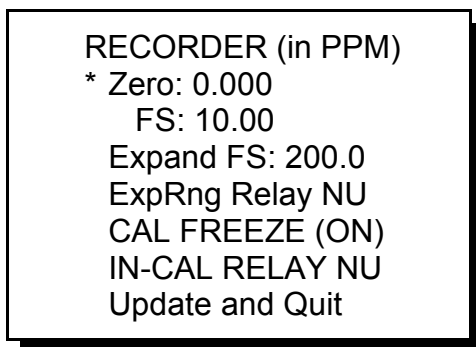
The electrolyte condition alarm is programmed in the same way as an O₂ alarm. However, the values for Hi Stpt, Lo Stpt and Deadbnd will indicate **NA**. These values cannot be accessed.

6.4.2 Analog Outputs

The **Outputs** entry in Figure 6-5 is used to scale the full range of the analog output (voltage and current) over a partial or full range of oxygen concentration.

NOTE: Alarm or Analyzer status conditions that signal an “Analyzer off-line” fault condition (such as sensor off) can be assigned to a single relay contact used as a trouble indicator. If the Analyzer signal is only monitored remotely, it is suggested to route the 4-20 mADC signal through the “Analyzer Trouble” relay such that an alarm condition will cause the relay to break the current loop. This method allows a computerized system to be configured to detect an analyzer fault condition whenever the 4-20 mADC signal is below 4 mA.

After accessing the Outputs Menu, the display will be as shown in Figure 6-10.

A screenshot of a menu titled "RECORDER (in PPM)". The menu items are: "* Zero: 0.000", "FS: 10.00", "Expand FS: 200.0", "ExpRng Relay NU", "CAL FREEZE (ON)", "IN-CAL RELAY NU", and "Update and Quit".

```
RECORDER (in PPM)
* Zero: 0.000
  FS: 10.00
Expand FS: 200.0
ExpRng Relay NU
CAL FREEZE (ON)
IN-CAL RELAY NU
Update and Quit
```

Figure 6-10: Recorder Output Set-Up Menu

From the Outputs menu, the recorder zero and full scale (FS) can be set. On Trace Analyzers, the values are in ppm; on Percent Analyzers, the values are in %. The selected Zero and FS values will be displayed underneath the oxygen reading in the Data Display Screen.

The Zero value corresponds to the lowest possible voltage and current output (0 VDC, 4 mA), while the FS (Full Scale) value corresponds to the maximum voltage and current output (0.1/1/5/10 VDC [see Section 4.6] and 20 mA).

The Zero to Full Scale window (FS setting - Zero setting) can be as narrow as 20% of the Analyzer's full scale range. This limit is based on the fact that oxygen information is in a digital format. Like a digital photograph it is only possible to magnify the information so much before there isn't enough resolution and the result is too grainy to use. Analyzers are shipped with a factory setting that corresponds to the full scale range of the Analyzer. For example, a 0-100 ppm Analyzer on first power-up would show OUT: 0.0-100.0 underneath the oxygen reading in the Data Display Screen, Figure 6-1.

Some examples of valid scaling for a 0-100 ppm Analyzer with standard resolution are:

Output (Zero to FS)	Percentage of Full Scale Used
0-20 ppm	20 %
20-40 ppm	20 %
10-50 ppm	40 %
0-100 ppm	100 % (Factory Set)
50-85 ppm	35 %

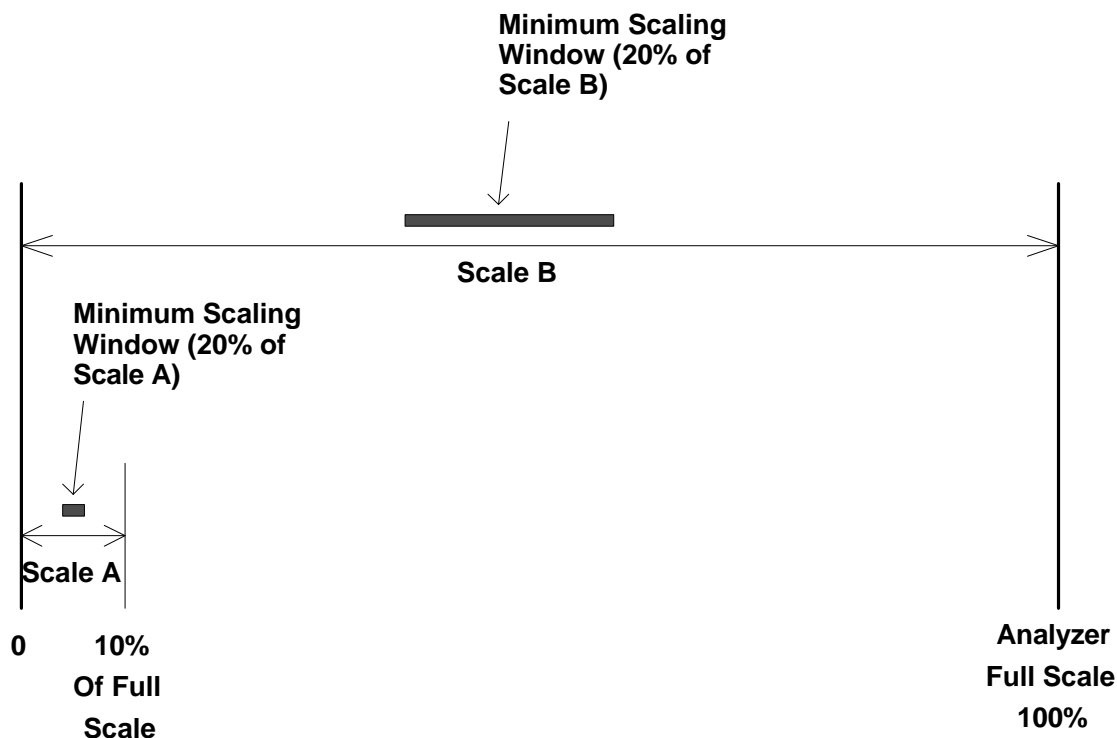
If an invalid Zero to FS window is entered the following error message will be briefly displayed (values are for a 0-100 ppm Analyzer):

```
RANGE TOO SMALL!!  
0 to FS must be  
20.0 ppm.  
Change one or  
press ESC
```

6.4.2.1 Scaling Analog Output Range On High-Resolution Analyzers

On High-Resolution Analyzers the instrument has two internal operating ranges: 0-10% of full scale (Scale A) and 0-100% of full scale (Scale B). When the oxygen reading decreases below 10% of full scale the analyzer automatically increases its internal gain by a factor of ten by switching to Scale A. This gain increase permits the front panel

oxygen display to provide an additional digit of displayed resolution. Refer to Section 3.1, Table 3-1, for a list of displayed resolutions. The increased gain also permits the analog output scaling to be set for from 20% to 100% of Scale A, in addition to 20% to 100% of Scale B. See Figure 6-11 for details.



- 1) Scaling Window = FS Setting - Zero Setting.
- 2) The scaling window may be located anywhere within either Scale A or Scale B.
- 3) For High-Resolution Analyzers the scaling window may be as small as 20% of either Scale A or Scale B.

Figure 6-11: Recorder Output Scaling For High-Resolution Analyzers

Using the High-Resolution model is preferred if the oxygen reading will usually be below 10% of the analyzer full scale reading and small changes in concentration (0.1% of full scale) must be detectable. The selected Zero and FS values will be displayed underneath the oxygen reading in the Data Display Screen.

Some examples of valid scaling for a 0-100 ppm High-Resolution Analyzer are:

Output (Zero to FS)	Percentage of Scale Used
0-2 ppm	20 % of Scale A
2-4 ppm	20 % of Scale A
1-5 ppm	40 % of Scale A
0-10 ppm	100 % of Scale A
0-20 ppm	20 % of Scale B
20-40 ppm	20 % of Scale B
10-50 ppm	40 % of Scale B
0-100 ppm	100 % (Factory Set)
50-85 ppm	35 % of Scale B

On all High-Resolution Analyzers, except the 0-50 ppm instrument, it is not possible to set an output that has an FS value that is within the 10 to 20 percent band of the upper scale, Scale B. An error screen will indicate that the output range is too small. The reason is simple: the 10 to 20% of full scale area is on Scale B. For Scale B the smallest window that may be set is 20% of the analyzer full scale, so FS values between 10% and 20% of full scale are smaller than this window.

For example: Zero: 0.0 (ppm), FS: 15.0 (ppm) would not be allowed on a High-Resolution 0-100 ppm Analyzer. The FS value of 15.0 (ppm) falls in the range of the upper scale (Scale B) and requires the upper scale minimum window size to be used. Therefore, 0.0 to 15.0 ppm spans only 15% of the upper scale (on a 100 ppm instrument) and is not allowed.

However, Zero: 0.0 (ppm), FS: 2.0 (ppm) would be acceptable because both values lie within a single scale, Scale A, and this range spans a band of 20% on Scale A (on a 100 ppm instrument). Similarly, Zero: 0.0 (ppm), FS: 10.0 (ppm) are acceptable inputs because they represent 100% of Scale A.

The High-Resolution 0-50 ppm Analyzer has a Scale A range of 0-2.5 ppm and a Scale B range of 2.5-50 ppm. On this Analyzer, the minimum Output Range on Scale A that could be set is:

Output (Zero to FS)	Percentage of Full Scale Used
0-0.5 ppm	20 % of Scale A

and, the minimum Output Range on Scale B that could be set is:

0-10 ppm	20 % of Scale B.
----------	------------------

If an invalid Zero to FS window is entered the following error message will be briefly displayed (values are for a 0-100 ppm Analyzer):

```
RANGE TOO SMALL!!  
2.0PPM < 10 % FS  
20.0PPM > 10 % FS  
Change one or  
press ESC
```

This message means that on Scale A (< 10 % FS) the minimum scaling window is 2.0 ppm, and that on Scale B (> 10 % FS) the minimum scaling window is 20.0 ppm.

6.4.2.2 Expanded Range Scale Operation And Setup

The expanded range scale option allows the analog output scaling to be automatically expanded to a larger value when the primary scaling range is exceeded. For example, in the display shown in Figure 6-10, the analog outputs (0-10 VDC and 4-20 mA) are scaled over the 0-10.00 ppm area. However, the Analyzer is a 0-500 ppm unit and if the oxygen value exceeds 10.00 ppm the analog output will peg. With the expanded range option it is possible to set a larger ppm range that will automatically rescale the analog output when the primary scale is exceeded. In the example, the analog output is scaled over 0-200 ppm as soon as 10.00 ppm is exceeded. If the oxygen level falls, the Analyzer will switch back to the original 0-10.00 ppm scaling as soon as the value is below 95% of the primary scale (9.5 ppm). This scaling change only affects the analog outputs.

When operating on the expanded range the analog output scaling information on the front panel will change to:

XPOUT: 0.0 - 200

When the asterisk is on the Expand FS line, each time the **↵** key is pressed a different full scale value will appear. In this way it is possible to scroll through a list of selections. The expanded range full scale value must be larger than the normal FS value, or the Analyzer will not accept the setting. Expanded range may be turned off at any time by setting Expand FS to NU. The zero point setting on the primary range is also used when operating on the Expanded Range.

6.4.2.3 ExpRng Relay

An alarm relay may be assigned to indicate when the expanded range is in effect. The relay will be in the “Normal” state when the analog output is on the primary range scale, and will switch to the “Alarm” state when the expanded range scale is in effect. If there are no relays installed this option will show **NA**. Since it is possible to assign more than one alarm or status condition to any alarm relay, it is important to ensure that there are no other items assigned to this chosen relay unless it is really desired.

6.4.2.4 CAL FREEZE

When a zero or span calibration is started CAL FREEZE holds the analog output at the last valid oxygen value prior to the calibration. The oxygen value remains held until the calibration is completed. This feature prevents a PLC or data acquisition system from “Seeing” a calibration. If the PLC is used to detect alarms, a calibration could involve sampling gas sources with concentrations above process alarm set points. CAL FREEZE may be turned off so that the analog output operates normally (follows the oxygen value) during calibration.

6.4.2.5 IN-CAL RELAY

This is a setup feature that allows an optional alarm relay to be assigned to indicate when the instrument is in the zero or span calibration mode. This feature may be used to signal a PLC, DCS or other external device when the instrument is in calibration (not sending “Process” O₂ data). Any relay may be assigned to IN-CAL RELAY service. If the Analyzer is not equipped with relays, this selection will be **NA**. Since it is possible to assign more than one alarm or status condition to any alarm relay, it is important to ensure that there are no other items assigned to this chosen relay unless it is really desired.

6.4.3 Comm Port

The Comm Port Menu, selected from Figure 6-5, is used to edit information about the external communications port. See Section 3.20 and 4.2 for details. This port operates with an 8 bit, no parity, one stop bit setting. No hardware or software handshaking is used.

After accessing the Comm Port Menu, the display in Figure 6-12 will be shown.

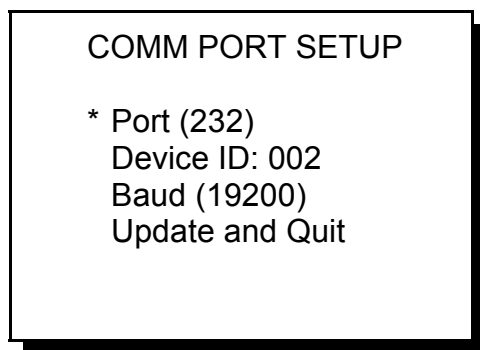


Figure 6-12: Comm Port Set-Up Menu

6.4.3.1 Port

Used to indicate if the data should be sent to the RS-232C port (232), the RS-485 (485) port or no communication port (OFF). Optional hardware must be factory installed to support either port option. It is not possible for the analyzer to be equipped with both the RS-232C and RS-485 option.

6.4.3.2 Device ID:xxx

Device ID is used to indicate the identity of the Analyzer. When using multiple Analyzers on an RS-485 loop the device ID is used as a unique address which allows Analyzers to be individually contacted by the communication software. The device number can be edited. The valid ID address range is 1 to 255. Even when equipped for RS-232 (one host communicating with one analyzer) it is necessary to set a valid ID address for the analyzer. The communication protocol uses the ID address as part of the data packet sent to the analyzer.

6.4.3.3 Baud

This setting is used to choose the data transmission rate. The options are 19200, 9600, 4800, 2400 or 1200. The Analyzer is capable of receiving 19200 Baud transmissions without requiring hardware or software handshaking. It is suggested that the highest data rate be used that reliably works in the application. In this way the system will be as responsive as possible.

6.4.3.4 Update And Quit

Update and Quit is used to accept the values set on this screen.

6.4.4 GSF

Refer to Section 6.4.5.1

6.4.5 Oxygen Calibration

The Oxygen Cal Menu is entered from Figure 6-5 when the user wants to check or adjust the Analyzer calibration. After accessing the Oxygen Cal Menu, the display will present Figure 6-13.

If the system has been previously recalibrated by the user, when the Oxygen Cal selection is made, an additional line will be added to the menu that states **Reset Orig Span** as seen in Figure 6-18. Section 6.4.5.2 provides more information about spans.

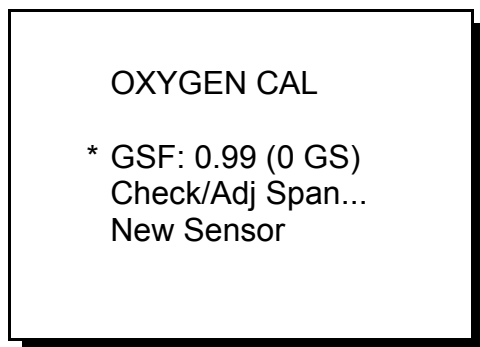


Figure 6-13: Oxygen Cal Menu

6.4.5.1 Background Gas Correction (Optional)

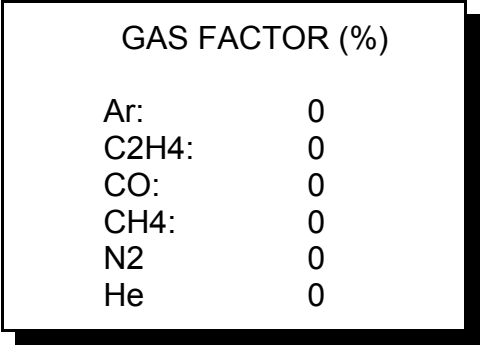
The optional GSF (Gas Scale Factor) is used to correct for changes in the rate of oxygen diffusion when background gases other than nitrogen are present in the sample gas. The GSF menu can be entered through Figure 6-5 or through the Oxygen Cal Menu, Figure 6-13. In many applications, the GSF is not required, i.e., GSF=1.00. However, for some background gases with significantly different diffusivities compared to nitrogen (such helium, hydrogen, or C₃ and heavier hydrocarbons), the GSF can be useful. To use GSF, enter the volumetric percentages of the sample gas as described

below. The GSF is automatically calculated. Alternately, the GSF factor can be entered manually.

The software in the Analyzer supports the following gases in the GSF calculation:

Ammonia	NH ₃
Argon	Ar
Butane	C ₄ H ₁₀
Carbon Monoxide	CO
Ethane	C ₂ H ₆
Ethylene	C ₂ H ₄
Helium	He
Hexane	C ₆ H ₁₄
Hydrogen	H ₂
Methane	CH ₄
Nitrogen	N ₂
Propylene	C ₃ H ₆

Contact the factory, for assistance with gases not listed above, at 781-935-5808. When **GSF** is selected, the display in Figure 6-14 will be shown.



GAS FACTOR (%)	
Ar:	0
C2H4:	0
CO:	0
CH4:	0
N2	0
He	0

Figure 6-14: Gas Scale Factor Menu

Entries for additional gases can be accessed by using the • or — key to scroll through the list. The entries spread across more than two screens. Continued pressing of \uparrow will give access to the additional choices, shown in Figure 6-15. By moving the asterisk to the appropriate line and pressing \uparrow , the volume percentage of the sample gas can be adjusted.

After the volumetric percent of the selected gas is entered, continue to press **↵** until the number is no longer in reverse video. Repeat the process for other gases in the sample gas composition.

Note: An error message will appear if the sum of gases does not equal **100%**. If that occurs, change one (or more) values and press **↵** again.

For percent oxygen Analyzers, assume oxygen has the same diffusivity as nitrogen. Thus, add the percentage of oxygen to the percentage of nitrogen when entering the percentage of nitrogen.

At the bottom of the list, the display will show Figure 6-15.

GAS FACTOR (%)	
C2H6:	0
C3H6:	0
C4H10:	0
C6H14:	0
GSF:	1.00
Update and Quit	

Figure 6-15: Gas Scale Factor Menu (cont.)

Note: Scrolling down the gas list from Figure 6-14 to Figure 6-15 will displace one line at a time. Because these figures are presented from the top and from the bottom of the gas list, H2 (Hydrogen) and NH3 (Ammonia) appear to be missing.

When the composition of the gas (or the GSF factor) has been entered move the asterisk to Update & Quit and press **↵**. The GSF will be calculated and displayed. If the GSF factor of the gas used to calibrate the system is already known, it can be entered directly. To enter the GSF directly, move the asterisk to the **GSF** line and press **↵**. Use the **•** , **—** and **↵** keys to enter the value.

CAUTION



The GSF for the gas used to calibrate the system may be different from that used during analysis. If the GSF is changed to reflect the composition of the calibrating gas, be sure to reset the GSF before analyzing samples.

Disclaimer

The method used to correct the calibration of the Delta F Oxygen Analyzer for measurement in non-nitrogen background gases is derived from a well known theoretical mass transfer equation. This equation accounts for the change in oxygen diffusion rates through different gases.

Although significant empirical work has been done in this field, it is generally accepted that the equation may be only 85-90% accurate. In addition, there is further error introduced when correcting for a "multi" component background gas. This may result in an additional 3-5% error. Correcting the calibration (for all combinations of background gases) using theoretical means has its limitations.

An alternate method when using a non-nitrogen or "multi" component background gas is to obtain a certified oxygen calibration standard which has been prepared in a background gas which models the average process sample. In this case any possible error introduced in using the theoretically derived correction factor is eliminated. Caution must still be used, however, as certified standards may also have inaccuracies associated with them.

Questions regarding the calculation of a background gas correction factor for a specific application should be directed to the Delta F Customer Support Services Department at 781-935-5808.

In light gas (H_2 or He) backgrounds, the diffusion rate of oxygen will be greater than that in nitrogen, resulting in a higher absolute current generated by the sensor. If the sample contains an oxygen concentration near the high-end of the instrument (e.g. 80 ppm on a 0-100 ppm unit), and consists of a light gas background, the current generated by the sensor may be too much for the electronics to source and will effectively put the instrument out of range. In such a case, it would be appropriate to use an analyzer of the next highest range (e.g. 0-500 ppm). Consult Delta F for application specific details.

6.4.5.2 Check/Adj Span

Note: A calibration should be performed only after the Analyzer has been operating at least eight hours. The door should be closed when calibrating the Analyzer to keep the sensor temperature stable.

It is not possible to perform a Span Adjustment if the TEMP OVER RANGE condition is occurring.

The **Check/Adj Span** entry in Figure 6-13 is used to adjust the O₂ calibration. Selecting Check/Adj Span will display the screen shown in Figure 6-16.

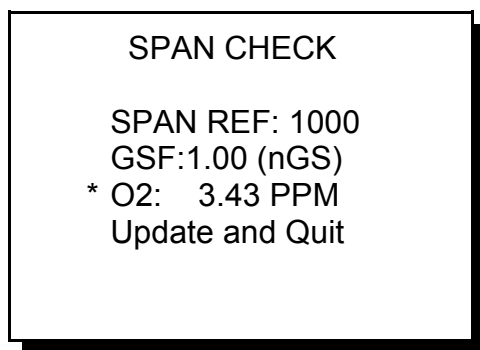


Figure 6-16: Span Check Menu

The GSF factor of the calibration gas can be entered directly or calculated by the instrument as described in Section 6.4.5.1. The legend (nGS) indicates the number of gases used to calculate the GSF. If n has a value of zero, it indicates that the factor was directly entered, or the default value of GSF=1.00 was used.

The Span Reference value **SPAN REF** is a numerical indicator for calibration changes made in the field. All instruments are shipped from the factory with a SPAN REF value of 1000. The number will decrease if the sensor's output decreases and vice versa. For example: For a 100 ppm Analyzer if a 70 ppm span gas is being used, the Analyzer reads 65 ppm, and an Oxygen Cal is performed, the Span Reference will change to 928 $([65 \text{ ppm} / 70 \text{ ppm}] \times 1000)$ following the calibration process.

The following information should be recorded at each calibration:

Date
Span Gas Value
Old Span Ref Value
New Span Ref Value
Time spent sampling Span Gas

Note: If the sensor has lost or gained significant sensitivity, verify the gas used as the calibration standard.

Review Section 5.4, Sampling Considerations During Calibration, for information regarding calibration standards, regulators, purging, and sample conditions. When introducing a calibration gas into the sample system, it is important to maintain the same pressure and flow conditions that occur during process monitoring.

CAUTION



Over-pressurizing the Analyzer can result in permanent damage to the sensor and optional pump. If the sample supply gas pressure exceeds 10.0 psig, install a pressure regulator in the inlet calibration gas line to regulate the pressure to 5.0 psig or less. The upstream flow control valve is used to set the flow at 2.0 (scfh).

If the normal process sample is being supplied to the Analyzer under moderate vacuum conditions (4" Hg vacuum or higher), such as when taxing the capability of the on-board pump, the Analyzer should be calibrated with the pump operating even if the calibration gas has sufficient pressure to preclude the use of the pump. The operating pump will create a pressure condition at the sensor that simulates the operating condition.

Analyzers with a pump are fitted with two flow control valves, one on the downstream rotameter and one on the sensor inlet (upstream of the sensor). Before turning on the pump, open the rotameter valve fully by turning it counter-clockwise. Close the upstream flow control valve completely (clockwise). Set the calibration gas regulator to less than 10.0 psig, then attach the calibration gas line to the Analyzer inlet. Use the upstream flow control valve to set the flow rate to 2.0 scfh. Turn on the pump and readjust the flow rate prior to calibrating.

Note: Do not adjust the valve at the rotameter, leave it in the fully open position during calibration.

For an accurate calibration, the sensor output must be stable. The time to achieve stability depends on the range of the Analyzer and the difference between the sample gas value and the span gas concentration. Typically, lower ppm range instruments require more time to achieve a stable output than higher ppm or percent instruments. The use of a chart recorder is suggested to monitor stabilization.

Note: Time required for the O₂ reading to stabilize when on span gas can vary from 15 to 60 minutes.

After a stable reading is obtained, enter the O₂ concentration of the calibration gas. Then press **↵** to complete the calibration.

A "Wait..." message will appear, followed by the display shown in Figure 6-17.

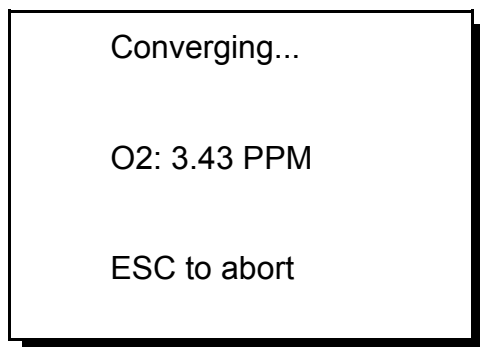


Figure 6-17: Calibration
Converging Screen

It may take several minutes before convergence occurs. During convergence, the Analyzer is verifying stability of the reading before accepting the data. After convergence two short beeps will be heard. The Analyzer's electronics can be updated to the new calibration information by selecting **Update and Quit**.

If convergence does not occur within 5 minutes, check the following:

- a. Make sure the gas connections are leak free.
- b. Make sure the sensor has been allowed sufficient time to have attained a stable reading on the calibration gas.
- c. Check the electrical connections to the sensor.

If all items check out, allow the Analyzer to operate an additional 30 minutes on calibration gas. Repeat the calibration. If the results are the same, contact the Delta F Customer Support Services Department at 781-935-5808.

To leave the Calibration before completing convergence, press ESC. The previous calibration will remain in effect.

If the system has been recalibrated by the user, when the Oxygen Cal selection is made from the SETUP MENU the display will appear as shown in Figure 6-18. The number in parenthesis next to the GSF will indicate the number of gases used (4 **Ga**Ses in the representative screen) to calculate GSF, or it will indicate the chemical formula for a single gas used (such as **He**).

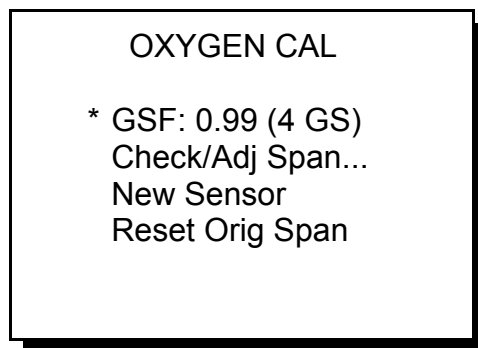


Figure 6-18: Oxygen Cal Menu
After User's Calibration

6.4.5.3 Reset Orig(inal) Span

The **Reset Orig Span** entry is used to restore the calibration that was made at the factory when the unit was manufactured, or the New Sensor calibration if the sensor has been field replaced.

If the **Reset Orig Span** entry is selected, the display will ask **Erase Cal?... [Y/N] FOR YES**. Press **[Y]** to use the factory set calibration. The bottom line of Figure 6-18 will disappear, and the factory span calibration will be restored.

6.4.5.4 New Sensor

The **New Sensor** entry is used after a new sensor is field installed. New sensors are supplied with calibration information. The procedure for installing a new sensor is described in instructions supplied with it.

CAUTION



Do not edit this entry without specific instructions from the Delta F Customer Support Services Department. Editing the entry will alter the stored factory calibration parameters and may cause dramatically erroneous operation. If the entry has been accidentally accessed, press ESC.

6.5 The Password Menu

The Platinum Series Process Oxygen Analyzer may include optional password protection which can be used to limit access to the Control Menu, the Set-Up Menu, and the Diagnostics Menu.

Note: When the Password entry is selected from the Main Menu, a **DISABLING ALARMS** message appears which notifies the user that the alarms have been temporarily disabled. The alarm overlay messages will not show in the display. **Relays will remain in the state that immediately preceded the Disabling Alarms message.**

The password operates on two levels, a Master Password to establish overall control of the system, and an Operator Password to allow partial access to the system. If the selected level requires a password, the display will present a password prompt.

The password menu is displayed in Figure 6-19.

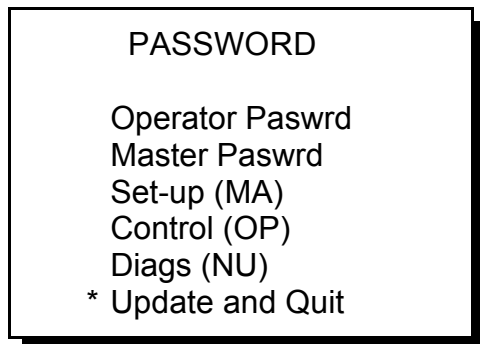


Figure 6-19: Password Menu

The two-letter codes adjacent to the **Set-Up**, **Control** and **Diags** entries in the display are used to indicate the level of password that is required to access the Set-Up, Controls or Diagnostics menus which are described in Sections 6.3 through 6.6. There are three possible settings for each entry:

- MA (Master) - Indicates that the master password must be used to access the menu.
- OP (Operator) - Indicates that the operator password or master password can be used to access the menu.
- NU (Not Used) - Indicates that no password is required to access the menu.

Note: When an Analyzer is shipped from the factory no password is installed.

To enter an Operator Password or Master Password, select the desired level. The display for an operator password is shown in Figure 6-20. The display for a master password is identical except the bottom line is blank instead of OP:.

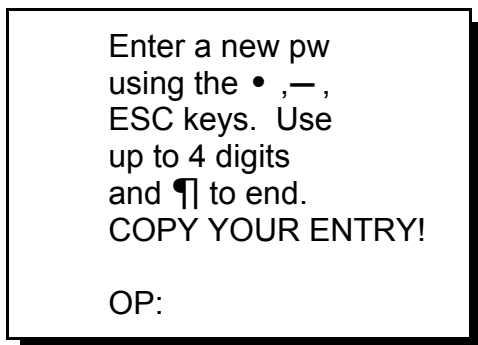


Figure 6-20: Password Entry
Screen

A password consists of a series of one to four keystrokes using the ESC, • and — keys. Password entry is completed by pressing ↵. Any combination of these keystrokes is acceptable. A typical password is •, ESC, —, —. After the fourth key is pressed in the Operator's Password, the display will automatically return to Figure 6-19. After the fourth key is pressed in the Master's Password, press ↵ to return to Figure 6-19.

CAUTION



The master password should be recorded in a secure location. Once the master password has been accepted, the Analyzer will not display it again. If the master password is misplaced, contact the Delta F Customer Support Services Department, at 781-935-5808, for assistance.

The master password and operator password can be changed as desired after the present master password has been entered. The new password(s) are activated by pressing ↵ when the asterisk is at **Update and Quit**.

To password protect a menu item (Set-Up, Control, Diags) use the • or — key to place the asterisk next to the item and press ↵. Subsequent pressing ↵ will cycle through **NU**, **OP**, and **MA**. When the passwords and the settings for all three menus have been set, select **Update and Quit**.

6.6 Diagnostics

Note: When the Diagnostics entry is selected from the Main Menu, a DISABLING ALARMS message appears which notifies the user that the alarms have been temporarily disabled. The alarm overlay messages will not show in the display. **Relays will remain in the state that immediately preceded the Disabling Alarms message.**

The Diagnostics menu is used to test different functions of the Analyzer. When this menu is selected and the password is entered (if required), Figure 6-21 is displayed.

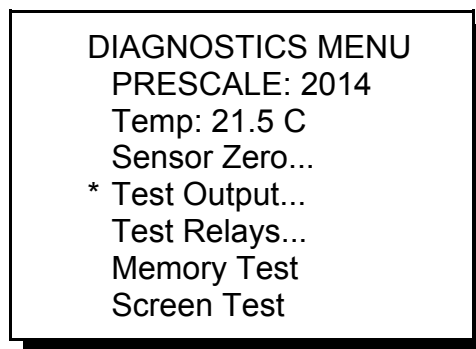


Figure 6-21: Diagnostics Menu

6.6.1 Prescaler

The prescale value is displayed but cannot be changed from the Diagnostics Menu. Prescaler values are used to adjust for sensor-to-sensor sensitivity variation, so it is only necessary to change the Prescaler value when a new sensor is installed.

6.6.2 Sensor Temperature

The display will indicate the present sensor temperature. There is no user action with this selection. This value does not update continuously; it is the last temperature reading before entering the menu. To obtain a new temperature reading, leave and re-enter the Diagnostics menu. New temperature values are available every 60 seconds.

6.6.3 Sensor Zero

The Sensor Zero entry is used to calibrate the zero baseline level of the sensor. The sensor zero baseline is calibrated at the factory and should not require any adjustments or checking under normal operating conditions. See Section 8.1.1 for details on normal operating conditions. If operating outside normal operating conditions contact Delta F for an application specific recommendation on checking the zero of the instrument in the field. Contact the Delta F Customer Support Services Department at 781-935-5808.

Should Delta F recommend checking the zero baseline calibration of the Analyzer, the following procedure can be followed: purge the sensor with gas that is free of O₂ until the output is stable. A suitable way to obtain an oxygen-free gas is to pass a pure grade of nitrogen gas through an oxygen purifier such as SAES MicroTorr™, Millipore Waferpure™ or Semigas Nanochem® resin purifiers. It is necessary to have a zero gas sample source that is assured to be at least one order of magnitude purer than the lowest resolution of the Analyzer.

Note: The difficulty in delivering a high quality zero gas to the Analyzer in the field can introduce significant error when attempting to zero calibrate the Analyzer. It is recommended that recalibration be done at the factory with its certified low ppb system. When checking zero calibration in the field, ensure that the gas system used to zero calibrate the Analyzer is leak-free by performing the low flow test described in Section 8.2.1.

Reaching a stable zero for the lowest range Analyzer may require 24 hours or longer, even assuming that the Analyzer has been running continuously for several weeks on a process application where readings are near the detection limits of the Analyzer. It is recommended that a recorder be used to chart the zero point, especially for low trace units. When the Sensor Zero entry is selected, the display will present Figure 6-22.

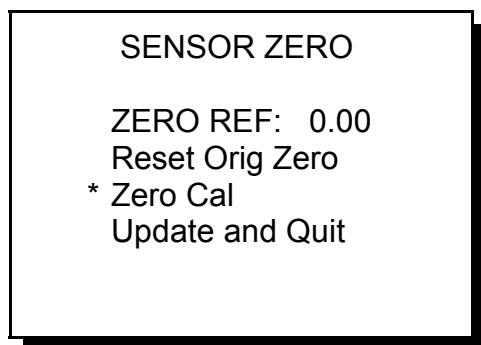


Figure 6-22: Sensor Zero Menu

6.6.3.1 ZERO REF

The **ZERO REF** value is a numerical indicator for calibration changes made in the field. All instruments are shipped from the factory with a ZERO REF value of 0.00. The number will become negative, following a user zero calibration, if the sensor zero is below the factory calibration and vice versa. This value should be recorded both before and after a Zero Calibration.

6.6.3.2 Reset Orig(inal) Zero

The **Reset Orig Zero** entry is used to restore the zero calibration that was made at the factory when the unit was manufactured, or the New Sensor zero calibration if the sensor has been field replaced.

If the Reset Orig Zero entry is selected, the display will ask **Erase?... [Y] FOR YES**. Press [Y] to use the factory set calibration. The Reset Orig Zero line of Figure 6-22 will disappear. It is necessary to select Update and Quit to make the reset permanent.

6.6.3.3 Zero Cal(ibration)

Selecting Zero Cal will result in the display shown in Figure 6-23.

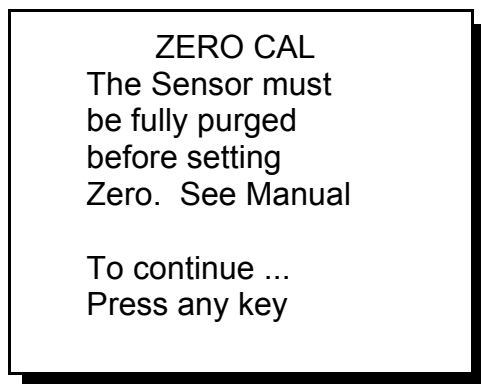


Figure 6-23: Zero Cal Warning Screen

Note: The zero baseline stabilization criteria is only verifying stability over a short time scale (1-5 minutes). The output on zero gas should be recorded (by manual or strip chart technique) and stability should be monitored over a much larger time scale (18 to 24 hours for 0-1000 ppm and lower range High Resolution Analyzers). Only when it is clear that the Oxygen reading has reached a constant minimum value should a zero calibration be attempted.

When any key is pressed, the display will show Figure 6-24 without the OFFSET: line. This screen will be overwritten with a "WAIT..." message for about ten seconds and then the OFFSET: line will appear. Two beeps will sound when the "WAIT..." message clears. When the offset is stable, the instrument will sound two short beeps and display a "STABLE" message on the blank line below ZERO CAL. The user has the option to accept the new offset value by pressing the **↵** key, or not accepting the new offset value by pressing the ESC key. With either choice, the display will return to the SENSOR ZERO Menu as seen in Figure 6-22.

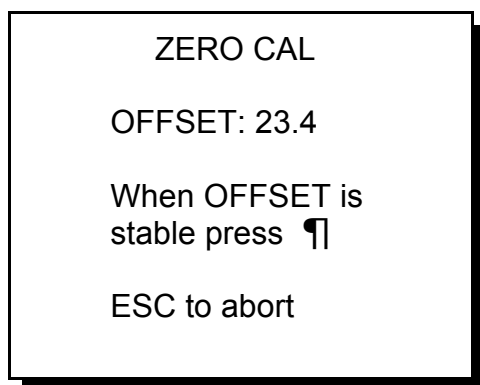


Figure 6-24: Zero Cal Screen

Pressing the ESC key at any time aborts the process and returns the user to the SENSOR ZERO menu.

If **↵** is pressed before the "STABLE" message is displayed the screen will change as shown in Figure 6-25.



Figure 6-25: Zero Cal, Not Stable Yet Screen

To accept the unstable OFFSET value press [F1]. This is not recommended! The offset value at this point may not be satisfactorily close to the eventual zero baseline level because the zero baseline level is still equilibrating. To resume stabilization (Figure 6-24) press ESC.

During Zero Cal the other messages that may appear below ZERO CAL are:

- | | | |
|-----------------------|---|--|
| INVALID DATA | - | Indicates that the instrument's analog-to-digital converter is reading a value which is over or under its full scale range. Check sensor's electrical connections and the delivery of oxygen free sample gas (see PRESCALER HIGH below). |
| PRESCALER HIGH | - | Indicates the oxygen concentration in the sample is too high. Check sample gas connection at Analyzer inlet for integrity, verify quality of sample gas and its purification equipment, and verify that sufficient purge time has been allowed for a stable output to be attained. |

If stable output is not attained after these conditions have been met, contact the Delta F Customer Support Services Department at 781-935-5808.

6.6.4 Test Output

The Test Output entry is used to calibrate the recorder. When the Test Output option is selected, the display will show Figure 6-26.

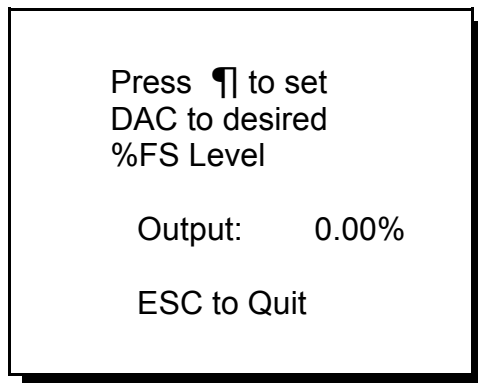


Figure 6-26: Output Test Screen

Use the \uparrow key to set the desired output level in percent of full scale. After setting the **% FS Level**, press \uparrow . The analog output response should match the %FS Level value that was entered. For example, if 80% is entered for the %FS value on a unit that has a 0-10 VDC recorder output, the output voltage should be 8.000 VDC.

6.6.5 Test Relays

The **Test Relays** selection in Figure 6-21 is used to assure that the relay outputs are functioning. When the Test Relays option is selected, the display will show Figure 6-27.

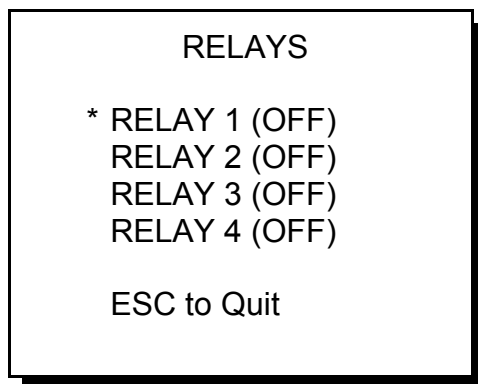


Figure 6-27: Relay Test Screen

Select the relay to be tested, then press **↵**. The relay will toggle between on and off each time **↵** is pressed. An audible click will occur. The condition of the relays before the test will be restored when the test is concluded.

6.6.6 Memory Test

The Memory Test selection is used to test the internal memory of the Analyzer. When the Memory test option is selected from Figure 6-21, the display will show Figure 6-28. Testing automatically begins.

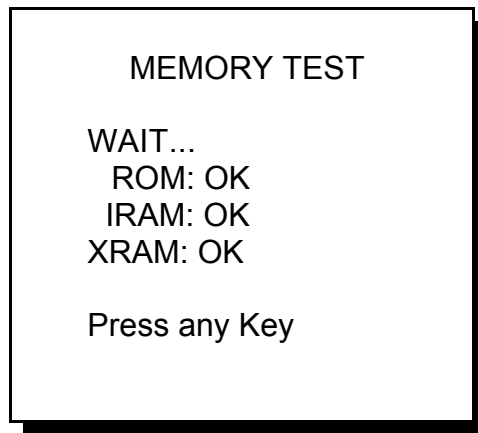


Figure 6-28: Memory Test Screen

During the ROM test the program EPROM contents is used to calculate a checksum, which is compared to a checksum that was stored in the EPROM at the factory. Any changes in the program code can be detected. Next, the microprocessor internal memory (IRAM) is tested, followed by the system “external” random access memory (XRAM). As each portion of the memory is successfully tested an OK will appear at the end of the line. If any memory test fails, repeat the test. If a failure is repeated contact the Delta F Customer Support Services Department at 781-935-5808.

6.6.7 Screen Test

When the screen test option is selected, the display will test each pixel. A series of horizontal lines will appear on the display, followed by a series of vertical lines. After the test has been completed, the display will return to Figure 6-21. Pressing ESC will abort the screen test. If an error message appears, or a pixel is inactive, contact the Delta F Customer Support Services Department at 781-935-5808.

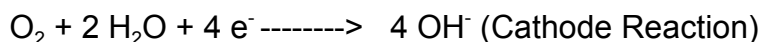
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7.0 Theory Of Operation

7.1 The Sensor

The sensor in the Platinum Series Process Oxygen Analyzer operates on a simple non-depleting coulometric principle in which oxygen in the sample gas is reduced by an electrochemical reaction. The use of this technique is widely recognized for its ability to provide the most accurate means of oxygen measurement because there is no consumption of either the sensor electrodes or electrolyte to cause long term drift or require sensor replacements.

Figure 7-1 is a diagram of the sensor configuration. The sample gas stream enters the sensor via the gas sample cavity. Oxygen is metered to the cathode through the Bi-Strata diffusion barrier. At the cathode, oxygen in the sample gas is electrochemically reduced:



The electrolyte solution contains potassium hydroxide (KOH) which assists in the migration of hydroxyl ions (OH^-) to the anode, where the ions are oxidized to reform molecular oxygen which vents out of the sensor:



A voltage of approximately 1.3 VDC, imposed on the sensor electrodes, drives the reduction and oxidation reactions. The resulting current is proportional to the oxygen content in the sample gas stream. The signal is processed, then displayed on the front panel as ppm or percent oxygen. If this polarization voltage is switched off, the O_2 reduction and oxidation reactions cease.

7.2 The STAB-EL Electrolyte System (Optional)

The Platinum Series Process Oxygen Analyzer can be equipped with Delta F's patented STAB-EL electrolyte system. STAB-EL allows the sensor to be used with gases that contain acidic components such as Cl_2 , HCl , CO_2 , SO_2 , H_2S , NO_x , etc. These gases are commonly termed "acid gases".

For many applications, the STAB-EL electrolyte system, together with the unique, non-depleting, electrochemical sensor electrodes eliminates the necessity of scrubbing the acidic components prior to making an oxygen measurement.

The STAB-EL electrolyte system consists of special measuring electrodes, sensor construction, and a second pair of electrodes placed within the oxygen sensor as shown in Figure 7-1.

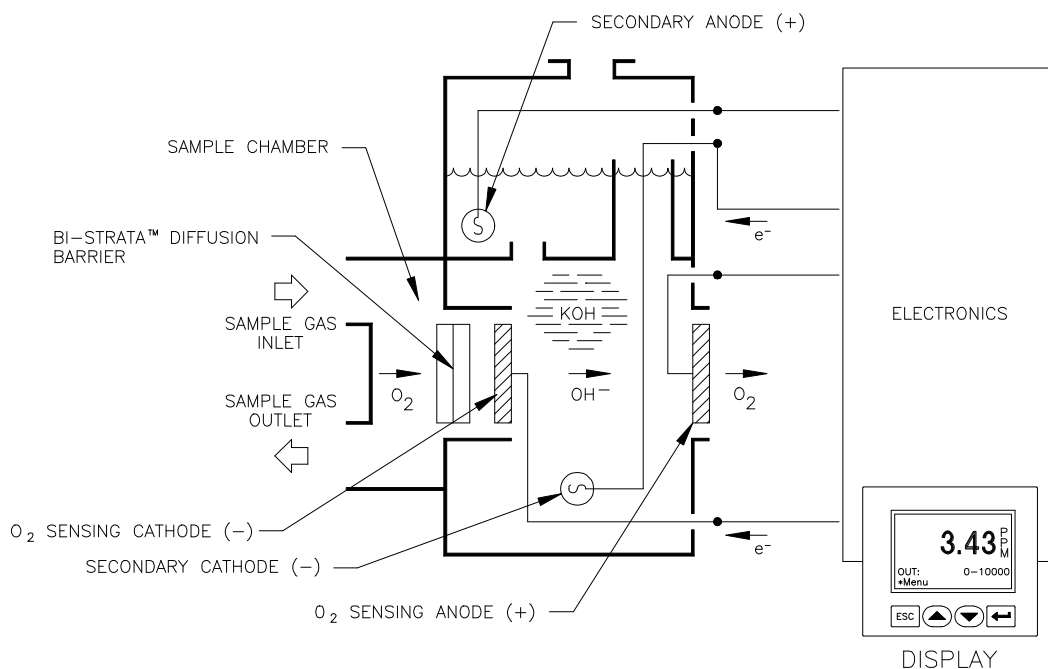


FIGURE 7-1 DIAGRAM OF THE SENSOR CONFIGURATION

A current flows between the secondary anode in the electrolyte reservoir and the secondary cathode in the sensor cavity. The electrodes are connected via immersion in the electrolyte solution.

In the STAB-EL system, anions (negatively charged ions) that are formed by the neutralization reaction of the acid gas with the KOH electrolyte will migrate to the anode. Cations (positively charged ions) are attracted to the cathode.

The constant secondary electrode current produces a modest water electrolysis reaction. Since potassium (K⁺) has a very strong equilibrium with OH⁻, the measurement cavity maintains an adequate concentration of hydroxyl ions to assist in the O₂ sensing reaction.

In a STAB-EL equipped oxygen sensor, acid forming components are prohibited from excessive buildup within the sensor cavity. Instead they are induced to migrate toward the reservoir where they concentrate.

The internal geometry of the sensor prevents back diffusion of unwanted anionic species into the measuring cavity.

The following sections cover common gases and gases that require special attention. Section 5.2.6 discusses the capabilities of the STAB-EL system in specific detail.

7.2.1 STAB-EL And Carbon Dioxide

In situations where the Analyzer is exposed to carbon dioxide (CO₂), carbonate ions are formed by reaction with the electrolyte. The anions will migrate to the secondary anode, where they will increase in concentration. When the solubility limit of the carbonate ion is reached, CO₂ will begin to effervesce from the reservoir solution.

7.2.2 STAB-EL And Gases In The Halogen Family

In situations where the Analyzer is exposed to halogen gases such as chlorine or fluorine, the anionic species will also migrate to the anode. However, unlike the situation with carbon dioxide, the anion will be oxidized at the anode and be vented from the sensor.

7.2.3 STAB-EL With Organic, Nitrogen, Or Sulfur Containing Acid Gases

In situations where the Analyzer is exposed to organic, nitrogen or sulfur-containing acid gases, the anionic neutralization species will migrate to the anode in the reservoir. Since these anionic species are not removed by effervescence or oxidation, they will continually increase in concentration. When the concentration becomes excessive, the electrolyte solution must be changed.

Frequency of electrolyte changes is directly related to the levels of acid gases in the sample gas. Typically, changes may be necessary 1 to 4 times per year. Actual operating experience will determine frequency of electrolyte change.

7.3 The Gas Scale Factor

The gas scale factor corrects for the diffusion rate of oxygen which varies with the composition of the background gas being analyzed. Delta F uses a Bi-Strata™ Gas Diffusion Barrier in the oxygen sensor. This barrier consists of a thick plate containing a specific number of holes. Each hole forms a small cylindrical space. The sample gas fills these spaces and oxygen molecules must travel through the length of the cylindrical

space to reach the sensor electrode. In this arrangement, the number of molecules that reach the sensor electrode, per unit of time, is affected by the molecular weight of the background gas molecules that the oxygen must travel through. If the background gas is very light, such as with hydrogen, the number of oxygen molecules per second that reach the electrode will be greater than if its molecular weight were heavier, such as with nitrogen.

In many applications, the GSF is not required, i.e., GSF=1.00. However, for some background gases with significantly different diffusivities compared to nitrogen (such as helium, hydrogen, or C₃ and heavier hydrocarbons), the GSF can be useful. Once the volumetric composition of the gas is entered into the software, the Gas Scale Factor is calculated and applied before reporting the concentration of the oxygen in the sample. The user has the option to manually input a Gas Scale Factor.

The software in the Analyzer supports the following gases in the GSF calculation:

Table 7-1
Supported Gases For Gas Scale Factor

Ammonia	NH ₃
Argon	Ar
Butane	C ₄ H ₁₀
Carbon Monoxide	CO
Ethane	C ₂ H ₆
Ethylene	C ₂ H ₄
Helium	He
Hexane	C ₆ H ₁₄
Hydrogen	H ₂
Methane	CH ₄
Nitrogen	N ₂
Propylene	C ₃ H ₆

Contact the Delta F Customer Support Services Department for assistance with gases not listed above, at 781-935-5808.

In light gas (H₂ or He) backgrounds, the diffusion rate of oxygen will be greater than that in nitrogen, resulting in a higher absolute current generated by the sensor. If the sample contains an oxygen concentration near the high-end of the instrument (e.g. 80 ppm on a 0-100 ppm unit), and consists of a light gas background, the current generated by the sensor may be too much for the electronics to source and will effectively put the instrument out of range. In such a case, it would be appropriate to use an analyzer of the next highest range (e.g. 0-500 ppm). Consult Delta F for application specific details.

7.4 Effects Of Gas Sample Flow Rate On Sensor Performance

Assuming a perfectly leak-tight system, the higher flow rates may cause O₂ readings to increase by a few percent of reading above the level that would be displayed if flow was within the recommended 1.0 to 3.0 scfh range. Lower flow rates will similarly cause O₂ readings to decrease by a few percent of reading. At very low flow rates (below 0.2 scfh), the incoming sample to the sensor is being scavenged of nearly all O₂, which is continuously being pulled into the sensor cathode by the electrochemical reduction process. This scavenging action makes the O₂ readings much more sensitive to flow rate changes. Therefore, if the Analyzer is recalibrated at a very low flow rate, the flow rate used during normal operation should be held within ±10% of the flow rate used for recalibration.

The Delta F sensor's insensitivity to flow rate changes is the basis for the low flow sample system leak detection method described in Section 5.3.4 and 8.2.1. The sensor output should be virtually constant for readings between 0.5 and 4.0 scfh. Therefore, if O₂ readings are higher at the lower flow, then the only explanation is that ambient O₂ is leaking into the sample system, or venting from a dead space (closed pocket with trapped higher O₂ level gas) in the sample system. In most cases a higher flow rate acts to dilute the O₂ leaking into the sample system. And a lower flow rate causes the leaked-in O₂ to have a greater contribution to the actual O₂ level, so readings go up. O₂ readings in a tight sample system should not go up or down significantly with flow changes between 0.5 and 4.0 scfh.

7.5 Pressure Effects On Sensor Performance

Sensor output may change with sensor pressure. Typically, sensor output increases as pressure increases, and decreases as pressure decreases.

There should be no concern with sensor pressure effects if the flow rate is set to 2.0 scfh and the Analyzer vents to atmosphere (assuming sea level). Sensor pressure will duplicate that of the factory.

If the Analyzer is not vented to atmosphere, the sensor pressure will be influenced by the conditions downstream of the Analyzer. A recalibration under the user's operating condition may be desirable to remain within the stated accuracy specifications. However, in most cases the error introduced is relatively small, and may not affect the process application.

Note: It is not recommended that gauges be installed upstream of the Analyzer. The presence of a gauge will increase purging requirements and response time.

For Analyzers with a pump, an outlet (vent) pressure greater than 3 psig will influence the sensor pressure, causing changes to the flow rate and output.

7.6 Temperature Effects On Sensor Performance

The electrical current output of the oxygen sensor operating on a constant sample concentration will change slightly with sensor temperature. Sensor output will increase with increasing sensor temperature and decrease with decreasing sensor temperature, particularly when oxygen readings are close to the sensor's zero level.

The Analyzer has software to correct the sensor output for these sensor temperature changes. This correction algorithm is designed for the "average" sensor of a given range. Since individual sensors may vary somewhat, the output of the Analyzer, even while employing the temperature compensation correction algorithm, may vary slightly especially if there are large temperature changes.

The effect of sensor temperature on output is specific to the range of the sensor. The trace range sensors experience more temperature sensitivity, while percent range sensors experience almost no temperature sensitivity.

7.6.1 Determining Maximum Temperature Effects On Analyzer Readings

The error calculations shown below can be used to predict the maximum Analyzer drift due to typical ambient temperature changes. Typical production Analyzers will drift less than this amount, however, use this calculation to predict the worst-case scenario. The temperature compensation algorithm is designed to consider temperature changes which are made slowly, and allowed to approach steady-state. If ambient temperature changes for a particular application are large and rapid, temporary transients in the sensor's output and/or the actual process gas oxygen concentration are likely to occur. The algorithm was not designed or tested under such extreme temperature transients. However, even for such extreme cases following a rapid temperature excursion, the algorithm will correct more accurately once the rate of temperature change decreases, or conditions approach steady-state. It will quite accurately correct for typically long and slow diurnal (day-night) ambient temperature changes.

Use the following table to determine a reasonable maximum error for a properly calibrated Analyzer due to a change in ambient temperature. There are two contributors to Analyzer drift which need to be considered. They are zero error and span error. These errors are a function of the Analyzer Range. The estimates in this table are from testing performed in the temperature range of 45°F to 95°F. At temperatures below 45°F or above 95°F, the temperature correction algorithm is still

working, but has not been evaluated to determine its effectiveness.

Table 7-2
Temperature Effects

Range of Analyzer	Zero Error Factor	Span Error Factor
0-50 ppm ["M" Series Sensor]	± 0.0010 ppm/°F	± 0.20% of Reading/°F
0-100 ppm	± 0.0020 ppm/°F	± 0.20% of Reading/°F
0-500 ppm	± 0.005 ppm/°F	± 0.20% of Reading/°F
0-1000 ppm	± 0.010 ppm/°F	± 0.17% of Reading/°F
0-5000 ppm	± 0.020 ppm/°F	± 0.17% of Reading/°F
0-10,000 ppm	± 0.100 ppm/°F	± 0.15% of Reading/°F
0-5%	± 0.500 ppm/°F	± 0.12% of Reading/°F
0-10%	± 1.000 ppm/°F	± 0.004% of Reading/°F
0-25%	± 2.500 ppm/°F	± 0.001% of Reading/°F

The temperature error calculation uses the factors from the above table for the appropriate Analyzer full scale range. To calculate the maximum temperature effect on a specific oxygen concentration the formula is:

$$\text{Error} = [\text{Zero Error Factor } (\Delta T)] + [[\text{Span Error Factor}/100] (\text{O}_2 \text{ Reading}) (\Delta T)]$$

Where ΔT = highest temperature (in °F) - lowest temperature (in °F)

Example:

A 0-50 ppm range Analyzer is reading 0.85 ppm at a temperature of 75°F. The temperature increases to 85°F. What is the maximum amount of change in reading possible due to the 10°F change in temperature?

Solution:

$$\text{Error} = [\pm 0.0010 \text{ ppm per } ^\circ\text{F} (10^\circ\text{F})] + [[\pm 0.20 \text{ ppm per } ^\circ\text{F}/ 100] (0.85 \text{ ppm}) (10^\circ\text{F})]$$

Simplifying:

$$\text{Error} = \pm 0.010 \text{ ppm} + \pm 0.017 \text{ ppm}$$

Finally:

$$\text{Error} = \pm 0.027 \text{ ppm}$$

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8.0 Service

If the Analyzer is to be returned to Delta F, it will be necessary to obtain a Return Material Authorization (RMA) number by contacting the Delta F Customer Support Services Department at 781-935-5808, or faxing to 781-932-0053.

8.1 Maintenance

The analyzer maintenance recommendations made in this manual apply to all Analyzers being operated under **Normal Operating Conditions** (as defined in Section 5.3.1) and in clean gas applications.

A clean gas application is one in which certain process conditions are met. The sample background gas must contain less than 10% of the acid gas limits shown in Table 5-1, Section 5.2.6 on a continuous basis. Solvents or other gases that are listed as “very soluble” to “infinitely soluble” in water must make up less than 0.1% of the background gas composition. Sample condensation must be avoided. For a hydrocarbon background gas, the sample must be kept at a temperature of at least 40°F over the sample dewpoint. A wet sample (high water dewpoint) must be kept at a temperature of at least 10°F over the dewpoint. The particulate density must be below the limit of 0.03 mg/L (weight of particulate matter / volume of sample at atmospheric pressure).

Some examples of clean gas applications include monitoring of high purity gas pipelines, compressed cylinder gases, cryogenic air separation plants, polyolefin feedstocks, glove boxes, and semiconductor process tools.

8.1.1 Calibration

All Delta F Platinum Series Process Oxygen Analyzers are calibrated with NIST (National Institute For Standards And Technology) traceable certified gas standards at the factory prior to shipment. No initial calibration is required upon receipt from the factory.

For Analyzers used in clean gas applications (as described above) and operated under **Normal Operating Conditions** (as defined in Section 5.3.1), we recommend verifying the span calibration every 12 months of continuous use. This can be accomplished by using the Analyzer to read a gas sample with a known concentration, such as a certified cylinder gas mixture of O₂ in N₂ background, available from any specialty gas supplier. For process applications containing more significant quantities of acid gases or particulate, or where liquids may be encountered, contact Delta F for a recommendation on calibration verification for your specific case. Refer to Section

6.4.5.2 for span verification instructions.

For Analyzers used in clean gas applications, and operated under **Normal Operating Conditions** (as defined in Section 5.3.1), there is no need for zero calibration checks in the field.

8.1.2 Storage Temperature

If the Analyzer is to be stored for extended periods of time, be sure that the temperature of the storage location does not exceed 122°F (50°C). Storage in direct sunlight can cause temperatures to exceed the recommended limits even though ambient temperatures may not.

8.1.3 Sensor Maintenance

The Analyzer does not require routine maintenance in most applications. The sensor may require periodic maintenance when a dry gas (a gas with a low dew point) is monitored for an extended time. Exposure to a dry gas gradually extracts moisture from the sensor, making it necessary to occasionally replenish the water in the electrolyte reservoir. High ambient sensor temperature (above the Recommended Range in Table 5-2) can increase the necessity of adding water.

CAUTION



If the electrolyte level is low, only **distilled or deionized water** needs to be added to the sensor. **Do not** add electrolyte solution to restore the electrolyte **level**. Do not overfill.

The Sensor Assembly consists of two connected chambers. The lower section contains the sensing electrodes which require total immersion in electrolyte. The upper chamber is the reservoir for electrolyte. The operation of the sensor will be satisfactory as long as the level of electrolyte is above the MIN indicator line on the reservoir label.

The sensor holds approximately 150 cc of electrolyte when full to the MAX line. Since the initial filling with one bottle of electrolyte is only 100 cc, deionized water can be added to reach the MAX line. Typical frequency for adding water varies depending on the sensor range and the application. Lower trace sensors (0-50 ppm and 0-100 ppm) may require water addition every 3-4 months of continuous operation on bone dry gas samples (the application where water loss is most significant). Middle range trace

sensors (0-500 ppm and 0-1000 ppm) may require water addition every 4-6 months of continuous use. Upper trace sensors (0-5,000 and 0-10,000 ppm ranges) may require water addition every 6-9 months of continuous use. Percent level sensors may require water addition at 9-18 month intervals. A typical check frequency for those sensors is recommended at once per year.

If the electrolyte level in the sensor is low (at or near the MIN indicator line on the sensor), add enough water (distilled or deionized, only) to bring the electrolyte level up close to the MAX indicator line on the reservoir label. The Oxygen Analyzer may be equipped with an alarm to indicate that the electrolyte level is very low; about 1/4" below the MIN line on the sensor. The operation of this alarm is described in Section 6.4.1.4.

To add water:

- a. Open the front door.
- b. Unscrew the black sensor cover.
- c. Slide the cover to one side (it will not fall off, nor can it be removed while the sensor is in the enclosure).
- d. Add distilled or deionized water using the supplied wash bottle. Fill to approximately mid-way between the min and max level indicator lines on the reservoir label. Be careful not to spill water on the electronics or on the outside of the sensor. Do not overfill.
- e. Replace the cover securely.
- f. Close the front door.

CAUTION



It is not necessary to turn off the instrument when replenishing water. However, care must be taken to avoid spills in the enclosure. Spills could cause damage to the electronics.

If the (optional) electrolyte condition alarm is reported while there is an adequate level in the sensor, the electrolyte may have been contaminated by exposure to incompatible gas components. The electrolyte should be changed, as follows:

To drain the electrolyte (which is a solution of KOH), remove the sensor from the cabinet as described in Section 2.2. Remove the cap and invert the sensor over a suitable receptacle. Flush the sensor twice with deionized water. Dispose of the electrolyte and rinse water in accordance with Federal, State and Local regulations.

Refill the sensor with electrolyte as instructed in Section 2.2. If the alarm is observed after returning the Analyzer to operation, contact the factory.

Note: Once the sensor has been charged with electrolyte, no further addition of electrolyte solution is required. The dissolved components in the electrolyte are neither consumed nor converted during operation, so only periodic replenishment with distilled or deionized water is necessary.

8.1.4 Replacing The Filter

The in-line gas filter should be replaced on a periodic basis. The lifetime of the filter element is dependent on the nature of the gas that is being analyzed, thus a general statement about the frequency of filter replacement cannot be provided.

For Analyzers in clean gas applications, if a filter is present, the filter should be inspected on a yearly basis. For other applications Delta F suggests that the filter be inspected on a weekly basis until the operator gains an understanding about the effect of the sample gas on the filter.

Replacement filters can be obtained from Delta F. Two grades are available:

Fine grade (BQ) (< 1 micron)	P/N 64005012
Course grade (DQ) (> 1 micron)	P/N 64005011

8.2 Troubleshooting

8.2.1 Sample System Leak Test (Low Flow Sensitivity)

By far the most common reason for high Oxygen readings is a leak in the sample delivery system. Leaks are divided into two types: real leaks and virtual leaks. A real leak is a lack of integrity in the sample delivery system. A virtual leak is caused by Oxygen that is trapped in the upstream plumbing and components, such as regulators and filters. This Oxygen is slowly being purged out of the system. Virtual leaks are most common in new installations.

Determining the nature of the leak is not a difficult task. It is important to be consistent in the approach and technique. The steps listed below will be helpful toward resolving any leak related problems.

- 1) Determine if the high reading is due to a leak or is a real indication of Oxygen level. This can be easily done by performing a "Flow Sensitivity Test". If the Analyzer is equipped with a pump, it is recommended that it not be used during the Flow Sensitivity Test. This test requires a positive pressure sample delivery system. If it is not possible to provide positive sample pressure to the Analyzer, skip to Step 2. Perform the Flow Sensitivity Test as follows:
 - a) Establish a flow rate that is within the normal operating tolerances of the Analyzer. Generally a flow rate of around 1 LPM or 2 SCFH is ideal.
 - b) Give the Analyzer a couple of minutes to stabilize, and then carefully note the flow rate and the Oxygen level displayed.
 - c) Reduce the flow rate by 75%. In a system with good integrity, there should be little change in the front panel display. If a leak exists, however, the reading will rise noticeably. Allow the reading to stabilize, and carefully note the flow rate and the Oxygen level displayed.
 - d) Re-establish a normal flow rate and allow the Analyzer to purge for ½ hour. Note again the flow rate and Oxygen level displayed.
 - e) Repeat step c. If the Oxygen level stabilizes at a level that is close to the prior value from step c, then the leak is real. If the reading shows a lower Oxygen level than the prior value from step c, the leak is probably a virtual leak and continued purging should rectify the problem.
- 2) Once it has been determined that there is a leak, the next logical step is to locate it. The easiest way to locate a leak is to close off the feed to the Analyzer from the sample delivery system, and to allow the system to pressurize. Apply Snoop® or another type of liquid leak detector to all of the fittings on the system. Any fitting that shows bubbles should be tightened or replaced.
- 3) If it is not practical to remove the Analyzer from the sample delivery system, leaks can be located by monitoring Analyzer output while applying Snoop® or another liquid leak detector to one fitting at a time. Snoop® will not show bubbles at the low pressure required for proper Analyzer operation. However, Snoop® will temporarily block any leak, at the fitting being checked, and the Analyzer output will drop. It is important to give sufficient time for the Analyzer to respond before going on to the next fitting.

The more distance between the fitting and the Analyzer, the more time should be given for the Analyzer to respond.

8.2.2 Basic Troubleshooting

Solutions are listed in the order that they should be attempted.

PROBLEMS	POSSIBLE SOLUTIONS
1) Analyzer reads low	A B D E H I F J Z
2) Analyzer reads high	A B C D E I J Z
3) Analyzer output is noisy	A E I Z
4) Analyzer reads high with pump on	C Z
5) Analyzer reads 0.00 at all times	Q D Z
6) Slow speed of response	G C D E F Z
7) Electrolyte residue (white powdery build-up) visible on the sensor	Z
8) Electrolyte Condition alarm "ON"	P D E Z
9) Display is blank, or shows an unusual appearance	K O Z
10) Display reads any of the following:	
- Over Range or TEMP OVER RANGE	L M N Z
- NOVRAM Failure	Z
- Uncalibrated	Z
11) Span reading is unacceptably high (>50% high)	R C J Z
12) Span reading is unacceptably low (>50% low)	R J E Z
13) Display normal but other outputs (0-10VDC, 4-20mA, etc.) read zero	S Z

- 14) Battery will not hold a charge (Analyzer will not operate on battery power, or BAT LOW message is always on) T U Z

SOLUTIONS KEY

- A) Check instrument performance using a gas standard of known Oxygen content (Span).
- B) Check that the Analyzer zero setting matches the original factory setting. Consult the factory to verify these settings.
- C) Check the sample delivery system for leaks.
- D) Verify that the correct voltages are being supplied to the sensor. These voltages should be checked with the leads disconnected from the sensor. The voltages measured should be as follows:

Primary Electrodes: wht/yel (-) to wht/blk/red (+) = 1.30 ± 0.03 VDC
Secondary Electrodes: wht/blu (-) to wht/red (+) = 6.0 ± 1.0 VDC

Note: For 25% instruments the above Primary Electrodes voltage should be 1.40 ± 0.03 VDC

Voltage levels between any other combination of wires should be less than 0.10 VDC. If there is any deviation from these values, contact the Delta F Customer Support Service Department at 781-935-5808.

- E) Change the electrolyte. Use only DF-E05 electrolyte supplied by Delta F. Other types of electrolyte can damage the sensor and will void the warranty. Always rinse and drain the cell with distilled or de-ionized water at least three times before refilling the sensor with fresh electrolyte. Fill the sensor with exactly one full bottle of electrolyte (100 cc) and top off the sensor with distilled or deionized water to the MAX line. Allow the Analyzer to operate for several hours on Nitrogen or other inert gas. A calibration check is recommended if performance was poor prior to the electrolyte change.
- F) Establish a flow of Nitrogen or other inert gas through the sensor. Reverse the positions of the two lower leads on the sensor. Turn the Analyzer on and allow it to operate in this fashion for at least 1 hour but not more than 3 hours. Immediately drain the sensor, flush three times with distilled or de-ionized water, and install fresh DF-E05 electrolyte. Return the sensor leads to their original

positions and allow the Analyzer to operate on a purge gas for several hours and attempt to calibrate.

- G) Remove and check the filter element. Replace if needed.
- H) Check for contaminated plumbing. This is most easily done by examining the rotameter (if so equipped) or Tygon tubing downstream from the sensor for evidence of oil, powder, or other material that may have made its way from the process to the Analyzer.
- I) Remove any devices being driven by the Analyzer output, i.e., chart recorders, data acquisition systems, etc. Also, disconnect anything controlled by the Analyzer alarm relays. Attempt operation with these devices removed.
- J) Ensure that the background gas is compatible with the Analyzers' current calibration. Otherwise, select the appropriate GSF value (if equipped with the GSF option), or offset the display readings externally by the appropriate Background Gas Correction Factor amount. See Section 6.4.5.1 for more information.
- K) Press the **¶** key once. If the display remains unchanged, power the Analyzer down momentarily, and then power it back up.
- L) Ensure that the Analyzer has adequate sample flow.
- M) Ensure that the sensor polarization voltage is turned on. See Section 6.3.4.
- N) Enter the Diagnostics menu and verify that the temperature is between 0 and 45 degrees C. If temperature indicates erroneously high, check for good contact at the red and black wires on the sensor harness connector (for Analyzers having the sensor in the cabinet), or at all remote wiring connection point (starting at rear panel connector J11 pins 1 and 2) for remote sensors. Also, in remote sensor applications, verify that the temperature sensor wires are not reversed.

Note: The sensor temperature reading is only updated when entering the Diagnostics menu. After checking wiring connections leave the Diagnostics menu, wait one minute, and enter the menu again. The temperature value will be new, and should now be correct.
- O) Check power supply fuse (on Power Control Panel, see Figure 1-2) and operating voltage.
- P) Add deionized or distilled water if electrolyte level is near or below "MIN" mark.

- Q) Check the sensor wiring. Make sure the nuts holding the wires to the sensor have not come loose. Trace the wires from the sensor back to the sensor connector. Make sure that the terminal pins are seated correctly in the connector plugs and are making good contact through the connector. Trace the wires further back to the backplane. Make sure the wires are soldered in and none have broken loose.
- R) Check the accuracy and age of the calibration reference cylinder. Trace O₂ standards in steel cylinders decay over time due to oxidation of the cylinder walls. Standards below 100 ppm, in steel cylinders, should be re-analyzed or calibrated every three months. Ideally, standards below 100 ppm, and certainly standards below 10 ppm, should be prepared in aluminum cylinders.
- S) Check the 100 mA, fast acting, output protection fuses on the analog output board.
- T) The battery pack has an integral $45 \pm 5^{\circ}\text{C}$ thermal cutout in the charging lead. If the Analyzer is operated in a warm environment this cutout may open and remain open because the reset temperature is approximately 20°C . Turn off the Analyzer, disconnect the battery pack, and place it into a refrigerator for an hour. Then reinstall the pack, charge for 15 hours, and attempt to run on battery power.
- U) Battery pack life is extremely dependent upon the number of charge/discharge cycles, how often the battery is discharged, how deeply it is discharged, and how long it remains discharged before being charged. It is nearly impossible to predict battery life, but as a general rule if the battery is more than two years old it may be suspected if the Analyzer will not run on battery power. If item T has not been successful, it is suggested that the battery pack be replaced.
- Z) Contact the Delta F Customer Support Services Department. The phone number is 781-935-5808. The fax phone number is 781-932-0053. For faster service, have the instrument serial number and model number in hand before calling. Always be certain to drain the sensor of electrolyte before returning it to the factory for repair.

8.3 Shipping

If it becomes necessary to ship the Analyzer to the factory or to another location, follow these instructions to prevent damage to the Analyzer during shipping.

CAUTION



The sensor must be drained and flushed prior to shipment. If the sensor is not drained, vibration during shipment nearly always loosens the sensor cap sufficiently to allow electrolyte to leak out of the sensor tank. Damage due to electrolyte leakage is not covered under the Delta F Warranty.

- a. Disconnect any source of AC power from the Analyzer.
- b. Disconnect all external electrical connections (e.g., alarms, data output, etc.) Mark each for easy reattachment later.
- c. Disconnect the sensor as described in Section 2.2.
- d. Drain the electrolyte into a receptacle suitable for proper disposal. See Section 9.2, MSDS, for proper handling and disposal precautions.
- e. Flush the sensor with distilled or deionized water. Thoroughly drain the rinse water into a receptacle. Repeat this step at least three times.
- f. Securely hand tighten the cover.
- g. Reinstall the sensor.
- h. Install the sample inlet bulkhead retaining nut. Hand tighten the nut until it is against the nut plate. Then, use a wrench to gently tighten the nut with a rotation of no more than 10 degrees. Excessive tightening will cause the nut to permanently freeze onto the fitting.

When shipping, use the original container, if possible. Ensure that all internal components are adequately secured. It is recommended that bubble packing or similar protective material be added inside the enclosure for additional support of the sensor tank, batteries, etc. If the Analyzer is being returned to Delta F, clearly mark the Return Authorization Number on the outside of the shipping container and on the packing list. The Analyzer should be returned to Delta F, freight prepaid.

9.0 Safety

9.1 General Warnings

DANGER



Line voltage exists in the Oxygen Analyzer Enclosure. If the enclosure door is open, DO NOT touch any of the electrical components when the Analyzer is connected to AC power.

CAUTION



Do not operate the Platinum Series Process Oxygen Analyzer at oxygen concentrations that are over-range for extended periods of time. Trace and low percent range sensors may be damaged if exposed to high levels of oxygen, e.g. air, for long periods of time (>15 minutes) while on power. If an exposure is unavoidable, turn-off power to the instrument, or deactivate the sensor polarization voltage (See Section 6.3.4).

- a. The sensor must be drained and flushed prior to shipment. If the sensor is not drained, vibration during shipment nearly always loosens the sensor cap sufficiently to allow electrolyte to leak out of the sensor tank. Damage due to electrolyte leakage is not covered under the Delta F Warranty.
- b. To reduce the risk of fire or electric shock, do not expose this equipment to rain or water spray.
- c. Disconnect power before removing the Sensor Assembly.
- d. Verify that the Analyzer power setting is consistent with the line voltage.
- e. Over-pressurizing the Analyzer can result in permanent damage to the sensor and optional pump.
- f. Do not operate an Analyzer unless a sample gas is flowing through the sensor.
- g. In remote sensor enclosures the heater components may be hot. Allow the heater to cool before accessing internal components.

- h. It is very important to use steel pan head 10-32 by 1/4" long screws to mount the filter and regulator bracket. Longer screws will damage the backplane PCB.
- i. The master password should be recorded in a secure location.
- j. The GSF for the gas used to calibrate the system may be different from that used for analysis. If the GSF is changed to reflect the composition of the calibrating gas, be sure to reset the GSF before analyzing samples.
- k. Do not edit the **New Sensor** entry without specific instructions from the Delta F Customer Support Services Department, available at 781-935-5808.
- l. **USE ONLY DF-EO5 ELECTROLYTE !!!**

9.2 Electrolyte Material Safety Data Sheet (MSDS)

The information below is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information. Liability is expressly disclaimed for loss or injury arising out of use of this information or the use of any materials designated. Users should make their own investigation to determine the suitability of the information for their particular purpose.

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE

Trade Name Electrolyte Solution, DF-E05, DF-E06, DF-E07, DF-E09

Manufacturer Delta F Corp., 4 Constitution Way, Woburn, MA
01801-1087, USA, Tel: 1-781-935-4600

Emergency Contact USA: 1-800-424-9300
International: 1-813-979-0626 (collect)

Supplier and contact in UK:
(for use in the UK only)

2. COMPOSITION

<u>CAS #</u>	<u>Component</u>	<u>EC Code/class</u>	<u>Concentration</u>	<u>Risk Phrase</u>	<u>Risk Description</u>
1310-58-3	Potassium Hydroxide in aqueous solution	215-181-3 C	1N: 5.6%w/w	R35	Causes severe burns

3. HAZARDS IDENTIFICATION

Main Hazard Corrosive. Causes severe burns on contact with skin, eyes and mucous membrane

CERCLA Ratings (scale 0-3) Health = 3 Fire = 0 Reactivity = 1 Persistence = 0

NFPA Ratings (scale 0-4) Health = 3 Fire = 0 Reactivity = 1

Potential Health Effects:

Eye Contact	Causes severe eye burns. May cause irreversible eye injury. Contact may cause ulceration of the conjunctiva and cornea. Eye damage may be delayed.
Skin Contact	Causes skin burns. May cause deep, penetrating ulcers of the skin.
Ingestion	May cause circulatory system failure. May cause perforation of the digestive tract. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death.
Inhalation	Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted. Effects of inhalation are irritation which may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.
Chronic	Prolonged or repeated skin contact may cause dermatitis. Prolonged or repeated eye contact may cause conjunctivitis.

4. FIRST-AID MEASURES

Skin Contact	In case of skin contact, remove contaminated clothing and shoes immediately. Wash affected area with soap or mild detergent and large amounts of water for at least 15 minutes. Obtain medical attention immediately.
Eye Contact	If the substance has entered the eyes, wash out with plenty of water for at least 15 - 20 minutes, occasionally lifting the upper and lower lids. Obtain medical attention immediately.
Ingestion	If the chemical has been confined to the mouth, give large quantities of water as a mouthwash. Ensure the mouthwash has not been swallowed. If the chemical has been swallowed, do NOT induce vomiting. Give 470 - 950ml (2 - 4 cups) of water or milk. Never give anything by mouth to an unconscious person. Obtain medical attention immediately.
Inhalation	Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted; however, if inhalation should somehow occur, remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid immediately.

5. FIRE FIGHTING MEASURES

Special Exposure Hazard	Not applicable
Extinguishing Media	Not Combustible. Select extinguishing media appropriate to the surrounding fire conditions.
Protective Equipment	Wear appropriate protective clothing to prevent contact with skin and eyes. Wear a self-contained breathing apparatus (SCBA) to prevent contact with thermal decomposition products.

6. ACCIDENTAL RELEASE MEASURES

Personal Protection	Use proper personal protective equipment as indicated in Section 8.
Leaks and Spills	Absorb spill with inert material (e.g., dry sand or earth), then place into a chemical waste container. Neutralize spill with a weak acid such as vinegar or acetic acid.
Clean-up Procedures	Wash the spillage site with large amounts of water.

7. HANDLING AND STORAGE

Handling Precautions	Complete eye and face protection, protective clothing, and appropriate gloves must be used. Do not get in eyes, on skin, or on clothing. Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Do not ingest or inhale.
Storage Precautions	Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal Protection	
Eyes	Wear appropriate protective chemical safety goggles and face shield as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin	Wear appropriate gloves to prevent skin exposure.
Clothing	Wear appropriate protective clothing to prevent skin exposure.
Respirators	Not Applicable. Inhalation under normal use would not be expected as this product is supplied as an aqueous solution and no hazardous vapors are emitted.
Airborne Exposure	This material is supplied as an aqueous solution and will not be present in the atmosphere in normal use.
Exposure Limits	Potassium Hydroxide UK EH40, OEL (8hr TWA) 2mg/m ³ NIOSH, (8hr TWA) 2mg/m ³ ACGIH, Ceiling 2mg/m ³ OSHA, not listed

9. Physical & Chemical Properties

Molecular Formula	KOH Mixture
Physical State	1N aqueous solution. Colorless, odorless
pH	Alkaline
Solubility	Completely soluble in water 104.5°C

Boiling Point	-3.5°C
Melting Point	Not applicable
Flash Point	Not flammable
Flammability	Not applicable
Explosion Limits	1.15
Specific Gravity	16.1 mm Hg @ 20°C
Vapor Pressure	

10. Stability & Reactivity

Chemical Stability	Stable
Conditions/Materials to Avoid	Incompatible materials, acids and metals
Incompatibilities with other Materials	Reacts with chlorine dioxide, nitrobenzene, nitromethane, nitrogen trichloride, peroxidized tetrahydrofuran, 2,4,6-trinitrotoluene, bromoform+ crown ethers, acids alcohols, sugars, germanium cyclopentadiene, maleic dicarbide. Corrosive to metals such as aluminum, tin, and zinc to cause formation of flammable hydrogen gas.
Hazardous Decomposition Products	Oxides of potassium
Hazardous Polymerization	Has not been reported

11. Toxicological Information

Toxicity (Potassium Hydroxide)	CAS# 1310-58-3: Oral, rat: LD50 = 273 mg/kg
Carcinogen Status	Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA

Potassium Hydroxide Solution is a severe eye, mucus membrane, and skin irritant.

12. Ecological Information

Mobility	Completely soluble in water
Degradability	Will degrade by reaction with carbon dioxide from the atmosphere to produce a non-hazardous product.
Accumulation	No
Ecotoxicity	Information not available. No long-term effects expected due to degradation. The preparation is already in dilute solution and adverse aquatic effects are not expected due to further dilution. The preparation is corrosive, and direct contact with fauna will cause burns.

13. Disposal Considerations

Waste Disposal Dispose of in a manner consistent with federal, state, and local regulations.

14. Transportation Information

	<u>Shipping Name</u>	<u>Hazard Class</u>	<u>UN Number</u>	<u>Packaging Group</u>
US DOT	Potassium Hydroxide Solution	8	UN1814	II
IATA	Potassium Hydroxide Solution	8	UN1814	II
ADR/RID	Potassium Hydroxide Solution	8	UN1814	II
IMDG Code	Potassium Hydroxide Solution	8	UN1814	II
Canadian TDG	Potassium Hydroxide Solution	8(9.2)	UN1814	Not Available

15. Regulatory Information

European/International Regulations
 European Labeling in Accordance with EC Directives

Classification	Corrosive	
Hazard Symbol	C	
EC Number	215-181-3	
Risk Phrases	R35	Causes severe burns.
Safety Phrases	S1/2	Keep locked up and out of reach of children.
	S26	In case of contact with the eyes, rinse immediately with plenty of water and seek medical advice.
	S36	Wear suitable protective clothing.
	S37/39	Wear suitable gloves and eye/face protection.
	S45	In case of accident or if you feel unwell, seek medical advice immediately (show label where possible).

16. Other Information

MSDS Creation Date: 09/30/94

MSDS Revised: 09/24/98

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10.0 Specifications

PERFORMANCE

ACCURACY:

Standard: Greater of $\pm 3\%$ of reading (not to exceed 1% of range for % Analyzers) or 0.5% of range.

High Resolution: Greater of $\pm 3\%$ of reading (not to exceed 1% of range for % range Analyzers) or $\pm 0.02\%$ of range (except ranges #100 ppm, $\pm 3\%$ of reading or $\pm 0.05\%$ of range).

Model FAH0100, ± 0.050 ppm

Model FAH0050, ± 0.010 ppm

RESPONSE TIME:

Typically less than 20 seconds to read 90% of a step change. Equilibrium time depends on the specific conditions.

OXYGEN SENSITIVITY: 3 ppb (FAH0050 Model, only)

RESOLUTION:

Range	Auto Scale A*	Display	Auto Scale B*	Display	Recorder Output Resolution (A/B ppb)
Trace (ppm)					
0 - 50	0 - 2.5	X.XXX	2.5 - 50	XX.XX	.5/12
0 - 100	0 - 10	XX.XX	10 - 100	XXX.X	2.5/25
0 - 500	0 - 50	XX.X	50-500	XXX.	
0 - 1000	0 - 100	XXX.X	100 - 1000	XXXX.	25/250
0 - 5000	0 - 500	XXX.	500 - 5000	XXXX.	125/1250
0 - 10000	0 - 1000	XXXX.	1000 - 10000	XXXXX.	250/2500
Percent					
0 - 5	0 - 0.5	.XXX%	0.5 - 5	X.XX	1250/12500
0 - 10	0 - 1	X.XXX%	1 - 10	XX.XX	2500/25000
0 - 25	0 - 2.5	X.XX%	2.5 - 25	XX.X	6250/62500

*Scale A applies to High Resolution models only. Scale B extends down to 0 ppm or 0% on Standard Resolution models.

OVERALL OPERATING TEMPERATURE RANGE (MIN. TO MAX.):

Gas sample: 32°F to 122°F (0°C to 50°C)
Sensor Temperature: 32°F to 113°F (0°C to 45°C)

Electronics Temperature
w/sensor in enclosure: 32°F to 113°F (0°C to 45°C)
w/remote sensor: 32°F to 122°F (0°C to 50°C)

STORAGE TEMPERATURE: Not to exceed 122°F (50°C)

SENSOR TYPE: Non-depleting Coulometric

SENSOR WARRANTY: Five (5) years (limited). See Section 11.

ELECTRICAL, ALARMS & DISPLAY

ELECTRONICS: Microprocessor-based

DISPLAY: 2.5 inch by 3.75 inch supertwist graphics LCD

ALARMS: Audible and Displayed. Up to 7 optional alarms comprised of 4 oxygen, temperature, low flow, and electrolyte condition.

STATUS CONDITIONS: Sensor Off, Expanded Range (optional), In-Calibration status conditions can be assigned to relays (optional).

OUTPUT: Software scalable, user selectable 0-100 mVDC, 0-1, 0-5 or 0-10 VDC standard. Minimum load resistance is 1K. Non-isolated 4-20 mA output standard. Maximum loop resistance is 1K. Built in 28 VDC loop supply. Optional fully isolated 4-20 mA output is available. Maximum loop resistance is 550 Ohms. Built in 15 VDC loop supply.

ALARM RELAYS:	Up to four, rated at 5 amps, 120/240 VAC; 30 VDC under resistive load. Set points independently adjustable. Contacts failsafe to alarm condition upon loss of power.
POWER REQUIREMENTS:	Analyzer, 25 Watts; AC Pump, 5 Watts; DC Pump, 10 Watts; Heater, 125 Watts max. 100-120 VAC, 50/60 Hz; 200-240 VAC, 50/60 Hz optional. Ni-Cd battery optional.
BATTERY OPERATION:	Operating time is up to 8 hours on a full charge. Operating time with a pump is approximately 4 hours. Charging time is approximately 15 hours. Charging time with a pump is approximately 24 hours.
EMI SENSITIVITY:	SAMA standard PMC 33.1, Class 3A, B for EMI susceptibility. CE certified version is available as an option.

CONSTRUCTION

WEIGHT:	18 lbs. (8 kg) Standard Model (no options)
DIMENSIONS:	12.2"w x 8.9"h x 10.2"d (31 cm x 22.6 cm x 25.9 cm) (with handle and gas fittings)

GAS SAMPLE CONDITIONS

GAS CONNECTIONS:	1/8" Compression inlet and outlet Standard 1/4" Metal-face-seal (Optional)
SAMPLE INLET PRESSURE:	0.2 psig to 1.0 psig; 15-20 psig with welded sample inlet (orifice restricted)
SAMPLE FLOW RATE:	1.0 to 3.0 scfh standard operating limits

GAS COMPATIBILITY:

Standard Sensor:

All inert and passive gases, including N₂, H₂, CO, Ar, freons, hydrocarbons, etc.

STAB-EL Sensor:

Limited tolerance to gas compositions containing "acid" gases such as CO₂, H₂S, Cl₂, NO_x, SO₂, HCl, etc.

GAS SAMPLE MOISTURE CONTENT: No limit (avoid condensation)

OIL/SOLVENT MIST:

<0.03 mg/L Standard limit
>0.03 mg/L Use filter

SOLID PARTICLES:

<0.01 mg/L Standard limit
>0.01 mg/L Use filter

11.0 Warranty

Delta F warrants each instrument manufactured by them to be free from defects in material and workmanship at the F.O.B. point specified in the order, its liability under this warranty being limited to repairing or replacing, at the Seller's option, items which are returned to it prepaid within one year from delivery to the carrier and found, to the Seller's satisfaction, to have been so defective.

Delta F's five (5) year Sensor Warranty offers extended protection such that, if any Sensor of a Delta F Oxygen Analyzer fails under normal use, within four (4) years after the expiration of the one-year warranty, such Sensor may be returned to the Seller and, if such Sensor is determined by the Seller to be defective, the Seller shall provide the Buyer a replacement Sensor at the then current purchase price, equal to such current price multiplied by a fraction thereof in which the numerator is the number of months from the date of shipment by the Seller of the defective Sensor to the time it is received back at Delta F Corporation and the denominator of which is sixty (60).

In no event shall the Seller be liable for consequential damages. NO PRODUCT IS WARRANTED AS BEING FIT FOR A PARTICULAR PURPOSE AND THERE IS NO WARRANTY OF MERCHANTABILITY. Additionally, this warranty applies only if: (i) the items are used solely under the operating conditions and in the manner recommended in the Seller's instruction manual, specifications, or other literature; (ii) the items have not been misused or abused in any manner or repairs attempted thereon; (iii) written notice of the failure within the warranty period is forwarded to the Seller and the directions received for properly identifying items returned under warranty are followed; and (iv) with return, notice authorizes the Seller to examine and disassemble returned products to the extent the Seller deems necessary to ascertain the cause of failure. The warranties stated herein are exclusive. THERE ARE NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, BEYOND THOSE SET FORTH HEREIN, and the Seller does not assume any other obligation or liability in connection with the sale or use of said products.

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Appendix A - Replaceable Spare Parts List

When ordering spare parts, always mention the Analyzer's model and serial numbers. It is imperative that this information be provided to ensure that the correct parts are provided. Contact the Delta F Customer Support Services Department, at 781-935-5808, to place an order.

NOTE: The Quantity column lists the amount of each item used on an Analyzer. Please be aware that many of the parts are related to options, and may not appear in every Analyzer. These items are marked with the designation "(Optional)". The recommended quantity of repair parts to stock depends upon a complex combination of factors: How many instruments are being supported, how far is the instrument location from Delta F (shipping time), and how rapidly must the Analyzer be repaired. If a repair stock is being established the Delta F Customer Support Services Department should be contacted, at 781-935-5808, for advice.

Part Number	Part Description	Quantity
<u>Printed Circuit Boards:</u>		
10413520	Main PC Board Assembly	1
10413360	Display PC Board Assembly	1
10413370	Power Supply PC Board	1
10416660	Analog Output PC Board Assembly	1
10416140	Isolated 4-20 mA PC Board Assembly (Optional)	1
10413350	Backplane PC Board Assembly (Non-CE)	1
10315210	Battery PC Board Assembly (Optional)	1
10216770	LCD Display Assembly	1

Cable Harnesses And Connectors:

13214220	Sensor Cable Harness (Without Temp. Probe)	1
13314410	Display To Backplane Cable	1
13215720	Battery Board To Backplane Cable (Optional)	1
59017300	Power Cord, 110 VAC	1
50980707	Plug-In I/O Terminal Blocks (8 pin)	2
50980708	Connector Key For Terminal Block (per dozen)	1

Part Number	Part Description	Quantity
<u>Optional Electrical / Electronic Assemblies:</u>		
44912310	RS-232 Interface Module	1
44912314	RS-485 Interface Module	2
48100000	Alarm Relay (SPDT, 5 Amp)	1-4
63000303	Diaphragm Pump, 110 VAC	1
63000305	Diaphragm Pump, 220 VAC	1
63000306	Diaphragm Pump, Battery Unit	1
16315700	Spare Battery Pack	0
15205960	Temperature Controller PC Board (R4 & R7, only)	1
14207770	Temperature Probe (In sensor)	1

Hardware / Plumbing Items:

Consult Factory With Model & S/N	Sensor Cell	1
51300014	Low Flow Switch (Optional)	1
64000003	Rotameter Without Valve	1
64000005	Rotameter With Valve (Optional)	1
62000024	Flow Control Valve	1
15015240	Sensor Tank Cap	1
60000023	Inlet Bulkhead Fitting (1/8" Compression)	1
60000023	Outlet Bulkhead Fitting (1/8" Comp., SS out only)	1
60002222	Outlet Bulkhead Fitting (1/8" Comp., flexible out only)	1
60040014	Inlet/Outlet Fitting (1/4" Compression, R7 Only)	1
61004401	Flame Arrestor Bulkhead Fitting (R7 Only)	1
65001000	Handle (Portable units only)	1
83950001	Rubber Feet	4
12415980	Welded 1/4" VCR Inlet Assembly (Optional)	1
14216390	Welded 1/4" VCR Inlet Assembly (Optional, R4 Only)	1
14212370	Damper Box Assembly	1
10216780	Sensor Mounting Bracket Assembly (R4 Only)	1
18314290	Sensor Mounting Bracket (R7 Only)	1
60300241	VCR Gasket (Welded Tubing With VCR Inlet, Only)	1
16317340	VCR 0.010" Orifice (VCR Inlet, Without Pump, Only)	1

Part Number	Part Description	Quantity
<u>Miscellaneous / Service Aids:</u>		
DF-E05	Electrolyte, 100 ml bottle	1
64005011	Filter Element, Coarse	1
64005012	Filter Element, Fine (Optional)	1
45002521	Fuse, 110 VAC, 2.5 Amp	1
45002361	Fuse, 110 VAC, 500 mA	1
45002441	Fuse, 220 VAC, 1.25 Amp (Optional)	1
45002301	Fuse, 220 VAC, 250 mA (Optional)	1
45002504	Fuse, 100 mA Fast Acting (For 4-20 mA & 0-10 VDC)	2
73000444	Plastic PVC Tubing (3 Foot Length)	1
83000001	Plastic Tubing Snap Clip	4
99000001	Instruction Manual	1
10216760	B-size PCB Schematic Package	0
10315290	Single Width Extender Board	0
10315280	Double Width Extender Board	0

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